*Some Notes on the Working Stress of Iron and Steel.

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The author has selected the above somewhat elastic title because, whilst anxious to accede to the request to bring certain results of his experience before the society, he has not had sufficient time in the pressure of other duties to analyze and arrange these results as he could wish.

Few engineers of experience who have had to deal both with machinery and with structural iron work, such as railway girders, can have failed to note inconsistencies in practice, and general vagueness as to the meaning and use of such terms as safe working stress of factor of safety. Rankine defines factor of safety as the ratio in which the ultimate strength exceeds the working stress, and assigns to it a value of four to six for ordinary steel and iron subject to a variable load. But if we consider for a moment how the proportions of almost all parts of a machine, from the axle of a country cart to the coupling rod of an express engine, have been arrived at, we shall see that it has been by the gradual strengthening of the parts which had proved by accumulated experience to be too weak, and not by calculating the dimensions on the basis of a factor of safety of four to six.

To illustrate this fact we cannot, indeed, select a better example than that of the coupling rod of a locomotive engine. Thirty to forty years ago the coupling rods in general use were round rods about 2¾ inches in diameter at the center and a trifle smaller at the ends. They were next changed to flat rods about 3½ inches deep by 1½ inches thick, and subsequently the dimensions were modified to 4 inches by 1¼ inches. Finally, we have now on many railways girder section rods 4¼ inches deep, 2¼ inches wide over the flanges, and ⅝-inch thick in the web. Why were the successive modifications introduced? Obviously as the result of experience, and not of calculation, or of increased power in the engines. The sectional area at the center of the round rod was 5.4 inches; of the first mentioned flat rod 5.25 inches; of the second 5 inches, and of the last 6.4 inches. In no case would the direct stress on the rod, even assuming all the power of the engine were transmitted through it to the coupled wheels, exceed 6,000 pounds per square inch; therefore, direct stress had nothing to do with the alterations. What happened was this: Failures occurred with the round rods, and some shrewd, practical man instinctively concluded that the fracture occurred from transverse stress, and altered the section to a deep flat bar better able to resist bending. Theoretical considerations show the justice of this conclusion. At a speed of fifty miles an hour, the stress on the round coupling rods of an old type Great Western Railway engine, the writer finds, must have been 14,500 pounds per square inch from centrifugal force alone, or say, 17,000 pounds, including the direct stress from the engine. This stress has since been gradually reduced until with the most modern girder section rods, the combined stress from centrifugal force and steam pressure does not exceed half of the above, or 8,500 pounds per square inch.

Now, what is the factor of safety in the latter instance? Under direct pull the coupling rod would stand an ultimate stress of say 50,000 pounds per square inch; under direct compression say 20,000 pounds; and under transverse stress, which, as we have seen is the one determining fracture, the calculated ultimate stress on the extreme fibers would be about 80,000 per square inch. Is the factor of safety here $\frac{80,000}{8,500} = 9.4$, or is it $\frac{17,000}{8,500} = 2$? Experience has shown that the coupling rods are sure to fracture ultimately if the stress reaches 17,000 pounds per square inch; and the writer's experiments, to be hereafter referred to, point to the same conclusion. By making the working stress half the breaking stress as determined by actual practice, adequate security is found to be attained.

As it is with coupling rods so it is with other parts of machinery. A pin or some other member repeatedly fractures; it is made somewhat larger and stands.

Let us now consider for a moment another class of structure—railway bridges. The Conway tubular bridge, which has carried the heavy traffic of the London and Northwestern Railway for the past thirty-six years, is 412 feet in span, and under its own weight the tensile stress is 13,000 pounds per square inch. With ordinary trains the stress is 17,000 pounds, and if covered with the heaviest engines in use on the line, 20,000 pounds per square inch. The ultimate strength of the riveted structure is about 42,000 pounds per square inch. No indications of weakness have developed during the thirty-six years' working, nor anything to suggest that the factor of safety, of say 2 to 2½, is unduly low.

On the other hand, railway experience has amply proved that with small span, and therefore light girders, such stresses as the above would quickly lead to destruction. For that reason, in structures such as the "Elevated Railway," of New York, the stresses are wisely limited to 8,000 pounds per square inch in the flanges of the girders, 7,500 pounds in the web bracing and 4,500 pounds where members are subject to alternate tension and compression. Although in Great Britain the government regulations still authorize 11,200 pounds per square inch on the net section, and in France 8,500 pounds on the gross section, irrespective of the character of the load or the span of the girder, engineers of the present day do not act up to these regulations. In Great Britain a stress of 9,000 pounds per square inch net section is seldom exceeded in light girders. In a recent German bridge over the Danube, the permissible stresses ranged from 6,900 pounds to 13,000 pounds; and in a recent Hungarian bridge, over the same river, from 8,700 pounds to 11,000 pounds per square inch, according to the character of the loading. In one of the latest French bridges the government authorized a stress of 11,400 pounds per square inch gross section, in lieu of the usual 8,500 pounds, on the grounds of the dead load constituting an exceptionally large proportion of the whole. Again, the Russian Government last year issued new regulations by which the limiting stresses were fixed at 8,500 pounds per square inch for bridges under 50 feet span, and 10,300 pounds for those over 100 feet span. Thus, whether we take the case of the coupling rod of a locomotive, or the bridge over which the locomotive runs, we find that engineers have learned by experience the important truth, that the strength of a structure or piece of mechanism cannot be determined by the simple process of breaking a piece of the material in a testing machine, but must be ascertained either by the gradual accumulation of the results of actual working, or by testing the material under conditions as far as possible analogous to those obtaining in the case under consideration.

Wöhler's experiments on the so-termed "fatigue" of metals are well-known. The writer, wishing to satisfy himself as to the behavior of modern structural steel under different stresses, has, during the past few years, carried out experiments in some respects similar to, and in others differing from, those of Wöhler's; and has also made analogous tests of hard steel and of iron. The experiments may be roughly classified under four heads: (1) Rotating spindles with a weight at the free end, causing alternate tension and compression on the fibers as the spindle revolves. (2) Flat bars bent in some cases one way only, and in other cases both ways. (3) Specimens so designed as to give alternate direct tension and compression on small pieces of metal; and (4) Full-sized riveted girders.

SERIES No. 1.

No.	Revolutions.	Stress per sq. inch.	Factor *a*.	Factor *b*.
		Soft Steel.		
1.	40,510	36,000	1.75	2.45
2.	60,200	36,000	"	"
3.	68,400	34,000	1.84	2.56
4.	92,070	"	"	"
5.	107,415	"	"	"
6.	128,650	"	"	"
7.	155,295	"	"	"
8.	14,876,432	26 000	2.42	3.4
		Hard Steel.		
9.	5,760	67,000	1.88	2.82
10.	7,560	65,000	1.93	2.90
11.	14,600	53,500	2.36	3.45
12.	16,300	"	"	"
13.	26,100	48,500	2.72	4.10
14.	32,445	51,000	2.40	3.60
15.	157,815	40 500	3.03	4.55
16.	472,500	34,000	3.70	5.55
		Best Bar Iron.		
17.	108,160	34,000	1.70	2.38
18.	110,000	35,000	1.66	2.32
19.	141,750	34,000	1.70	2.38
20.	389,050	32,000	1.90	2.65
21.	408,000	30,000	2.00	2.80
22.	421,470	32,000	1.90	2.67
23.	480,810	31,000	1.95	2.75

The above series includes a representative number of the writer's experiments with rotating spindles. As a rule, the spindles were 1 inch diameter, and projected about 10 inches from the end of the revolving shaft in which they were fixed. A speed of between fifty and sixty revolutions per minute was maintained day and night. The "soft steel" was fine rivet steel, having a tensile strength of from 60,000 pounds to 64,000 pounds per square inch, and an elongation of 28 per cent. in 8 inches. The "hard steel" was a high-class "drift" steel, having a tensile strength double the above, and an elongation of one half the extent. The "iron" was the best river iron, having a tensile strength of from 58,000 to 61,000 pounds, and an elongation of 20 per cent. "Factor *a*" is the ultimate tensile strength per square inch of the specimen divided by the calculated stress upon the outside fibers, due to the load on the end of the projecting bar. "Factor *b*" is the ratio of the static load required to bend the bar a moderate amount beyond the elastic limit, to the load actually imposed upon the revolving bar. These definitions will be made more clear in further references to the table.

SERIES No. 2.

No.	Bends.	Stress per sq. inch. *Soft Steel.*	Factor *a*.
24.	12,240	44,000	1.59
25.	12,325	"	"
26.	12,410	"	"
27.	18,100	42,000	1.67
28.	18,140	"	"
29.	72,420	36,000	1.94
30.	147,390	34,500	2.03
31.	262,680	34,000	2.05
32.	1,189,200	27 500	2.55
33.	3,145,020	34,500	2.03
		Best Bar Iron.	
34.	184,875	34 000	1.68
35.	250,515	"	"
36.	3,145,020	"	"

The above series is a selection from the writer's experiments with flat bars bent laterally. Generally the bars were 1 inch wide by ½ inch thick, and 32 inches long between the bearings. The steel specimens were cut from the tension member plates of the Forth bridge, and had a tensile strength of about 70,000 pounds per square inch, and an elongation of 20 per cent. in 8 inches. The iron specimens were rolled bars.

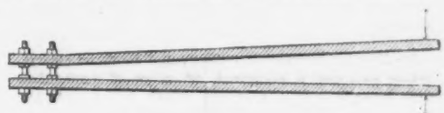

Fig. 1.

Fig. 2.

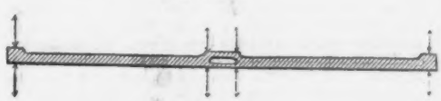

Fig. 3.

A careful consideration of the results of the preceding experiments will, the writer thinks, illustrate many points of interest to practical engineers. Experience has shown that screw shafts, and axles generally, made of the finest quality of high tension steel are not practically as strong as when made of soft steel, having theoretically perhaps little more than half the strength of the former. Referring to Series No. 1, we find, comparing experiments 8 and 14, that under working stresses in each case equal to about 40 per cent. of the ultimate strength, the hard steel failed with only 32,445 revolutions, while the soft steel stood 14,876,432. Again, comparing experiments 16 and 23, it will be seen that with practically the same number of revolutions the hard steel, though more than double the tensile strength of the iron, broke under a working stress only 10 per cent. greater. It is impossible, in the face of results such as these, to contend that the ordinary laboratory tests of a metal give any adequate measure of its value as a material of construction.

Iron of high quality holds its own, as compared with mild steel, in these experiments, and this is consistent with the general experience as to the driving axles of locomotives, which are subject to repeated bendings of considerable severity. Certain of the soft steel specimens would have given higher results had they not been turned down as fracture occasionally appeared to have been accelerated by the slight tool marking. On the other hand, No. 8 stood exceptionally well, although it was a turned down specimen. All of the hard steel bars were put in with the skin on.

An illusion entertained by some engineers that alternating stresses are destructive only if the stress exceeds the elastic limit, is effectually disposed of by

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these experiments, because none of the stresses in question exceeded the said limit and some of them were very far below it. Thus, in experiment 16, the working stress was but one-half of the stress at the elastic limit under direct tension, and only one-third of the stress at the elastic limit of the material when under transverse stress; which was really the condition of the specimen in the experiment. "Factor *b*," in the case of experiment 16, has a value of 5.55, which means that less than one-fifth of the static weight required to bend a hard steel pin a small amount, will suffice to fracture the pin if the stress be alternating, as in the case of the pins of connecting rods, for example. If we take what is usually termed the breaking load, or, say in a ductile material like steel, the stress which would deflect the bar as a beam an amount equal to half the span, then the load which ultimately broke the bar in experiment 16, was only one-seventh of the original static breaking load—a sufficiently remarkable result.

Other points of interest may be referred to in connection with Series 2. In general the bars were tested in pairs, so that when one bar broke its companion could be otherwise tested and examined. For example, the companion to No. 28, after being subjected to 18,140 bendings, was tested for tension, and failed with 48,000 pounds per square inch, and 2.6 per cent. elongation; the original strength of the steel being 70,000 pounds and 20 per cent. elongation. Again, the companion to No. 32 was, on close examination, found to have a flaw like those found in crank shafts. Nos. 33 and 36 were companion bars bent one way only, so that the stresses were not alternating, hence the largely increased endurance. They were both taken out before actual fracture, but with deep set flaws, clearly illustrating that the cause of failure under repeated stresses is very frequently not so much a gradual deterioration or crystallization of the metal, as the establishment of small but growing flaws. This, of course, is well known to locomotive and marine engineers; and on some railways it is the custom to run crank axles until the incipient flaw is detectable, and then to hoop the webs of the cranks; whilst marine surveyors do not condemn a shaft necessarily on the first appearance of a flaw, but license it to be run for a further definite period.

Another noteworthy fact illustrated by these experiments was, that a structure or piece of mechanism may be subject to a repeated stress equal to 90 per cent. of that which would break it, and yet specimens cut from the metal may exhibit no signs whatsoever of deterioration. The broken half of nearly every specimen in Series No. 2 was tested by the writer with that result. Thus, as the stress was applied at the center of the bars, it followed that at a point 90 per cent. of the half span from the bearings, the stress would be 90 per cent. of that which broke the bar. Although the bars broke short off at the center, at the point referred to, they could invariably be bent double without fracture. Having reference to this fact, and to the fact that the tensile strength was also little affected it is clearly hopeless to expect to learn much from testing specimens of metal from structures or machines which have been long in use. Unless the experimenter happens to hit off the right moment immediately preceding the commencement of failure, he need not expect to learn much from the behavior of the metal in the testing machine. Professor Kennedy, in an interesting and instructive lecture recently delivered before the Royal Engineers at Chatham, has given the results of tests of forty-seven pieces of iron and steel, which had either been in constant use for many years until they were so much worn as to require renewal, or, which had broken in actual use; but in no case did he find anything distinctly pointing to a weakening effect due to actual fatigue. This is exactly the result which the writer's experiments would have led him to anticipate; but it by no means follows that the very piece of metal tested by Professor Kennedy and found uninjured would not have broken a few days after in actual working. A man of seventy years of age may be as sound as he was at twenty; but the fifty years have told on him nevertheless, and the breakdown is certainly near and may be sudden. Having referred to Professor Kennedy's lecture it is necessary perhaps for the writer to say that he does not agree in some conclusions set forth therein. Thus, Professor Kennedy expresses his belief that the failure of coupling rods occurs as much by the gradual disintegration of the dirt between the laminations, and the oxidation of the iron, as by vibration and repetition of load; and that a homogeneous material like steel remains comparatively uninjured by repetition. This, of course is negatived by the results of the experiments cited in the present paper. Professor Kennedy further says: "If a load exceeding the limit of elasticity be applied a considerable number of times the bar will be actually broken, but at the same time we know that if any load exceeding the limit of elasticity be but once applied the structure to which the bar belongs is distorted and rendered useless." This, the writer thinks, is a dangerous fallacy tending to delay the application of truly scientific principles to the design of structures and mechanism.

Both the bridge engineer and the machinician must reckon with the fact that, owing to the contingencies of manufacture, parts of the metal in every structure are subject to initial stresses exceeding the elastic limit; but fortunately it is not true that the structure is thus "rendered useless." Almost every plate and angle bar of the bridge is cold straightened before going into the work, which means, necessarily, an initial stress exceeding the elastic limit. Boiler shells are bent cold, and heavy initial stresses close up to the elastic limit remain permanently in operation. The writer has calculated the intensity of these stresses, and verified his results by cold straightening bars, planing away the outside skins on each side and thus relieving the bars of one couple of initial stresses, and leaving the other couple near the neutral axis to operate. The result has been that the bars have ceased to retain their straightness, and have become curved to the extent of ¼ inch, or other amount indicated by calculation. Similarly, lathesmen well know that a long shaft often wobbles when the outer skin is turned off, and many other instances will occur to practical men, proving beyond contest that, in almost every metallic structure, some parts of the metal are stressed beyond the elastic limit.

The effects of repetitions of stress cannot therefore be ignored even where the nominal, or average, stress on the metal is small, because the possible heavy initial stress near the neutral axis may lead to the establishment of a growing flaw, commencing at the center of the cross-section of the bar and therefore undetectable.

As regards riveted structures it is of course the aim of both engineer and manufacturer to ensure every rivit gripping the plates with a stress fully up to the elastic limit. M. Considére, who has recently completed a most important and scientific series of experiments on riveted joints, sums up thus: "In all constructions in which the riveted portions have not already commenced sliding, the rivets work solely by longitudinal tension, and the adherence which this tension gives rise to between the plates in contact constitutes the sole resistance." And further: "Any alternating stress in excess of that adherence rapidly dislocates the work." The writer's experiments fully confirm these conclusions. At the Forth bridge the rivets in the heavy bedplates are 1⅛ inch diameter and pass through 8 inches thickness of plates. Closed with hydraulic riveters of 40 tons pressure, the rivets as a as a rule fill the holes fairly: but care is taken that the stress is kept within the frictional adherence arising from the elastic grip of the rivets. With rivets of the same length as those in the bedplates the average resistance to sliding was found to be equivalent to a shearing stress of 14,500 pounds per square inch of rivet area; whilst the maximum shearing stress on any rivet in the bridge is limited to 11,200 pounds per square inch. M. Considére found that with ordinary riveting he could reckon up an adherence of from 11,300 pounds to 14,400 pounds per square inch, which closely agrees with the former results. The writer, by testing plates in ordinary condition secured with bolts screwed up to a known tension, found the co-efficient of friction averaged ½d; and he also found the soft steel rivet after being closed up under hydraulic pressure had an increased ultimate strength of 10 to 15 per cent., and an elastic limit of about 45,000 pounds per square inch. Now 45,000 pounds × ½ = 15,000 which was the ascertained resistance to sliding of the plates: and it is clearly demonstrated, therefore, that in sound work the rivets are permanently strained up to the elastic limit. This result was further confirmed by temperature experiments, measurements of contraction of rivets, and other means which need not be detailed here.

In order to ascertain whether alternating stresses were as prejudicial to members, such as piston rods, subject to direct pull and thrust, as to shafts subject to transverse bending, the writer carried out a series of experiments on specimens so designed as to give alternate direct tension and compression on small pieces of metal. These specimens were of three types illustrated (not to scale), by Figs. 1, 2, and 3. In the first, the pieces of metal tested were sometimes of round and sometimes of flat cross-section, and were bolted to a couple of spring-bars, as shown on the sketch; the stress being applied by opening and closing the legs of the tongs, and thus putting the metal into alternate tension and compression. In the second group, the spring bars and specimens were all sawn and slotted out of one piece of steel, and the necessity of constantly tightening up the nuts was thus avoided. In the third the specimens were shaped as shown by Fig. 3, and a bending stress applied at the center of the bars.

Other experiments were made, but the above are sufficient to prove that alternating stresses are at least as prejudicial when the stresses are direct as when they are indirect.

SERIES No. 3.

Soft Stee

No. of bends.		Stress per sq. inch.	Factor *a*.
Fig. 1.	28,008	37,000	1.90
	49,320	38.000	1.84
Fig. 2.	11,880	28,000	2.50
	29,568 (hard steel).	16,700	4.90
Fig. 3.	230,513	35,000	2.00
	294,735	25,000	2.80

SERIES No. 4.

The writer has availed himself of the opportunity afforded by the large use of special plant and machinery at the Forth Bridge Works, to note the influence of varying stresses on full-sized riveted steel girders. These observations are still in progress and can be but very briefly referred to herein. In one instance the lever of a large plate bending press is of box girder section, built up of eight 4" × 4" × ⅝" angle bars, two 13" × ⅜" web plates and two 17" × ⅜ × ½ flanges. The span is 15 feet 8 inches, and the ordinary daily working stress on the metal is 43,000 pounds, and occasionally 57,000 pounds per square inch. Many thousand applications of this stress have been made, and the beam has taken a permanent set of ⅞-inch, but so far is otherwise intact. Observations are also being made of the behavior of sixty riveted steel box girders of 18 feet span, built up of two 12" × 3" channels and two flange plates; which girders are subject to very many thousand repetitions of stress ranging from zero to thirteen tons per square inch.

As regards the important question of the proper working stress on iron and steel, the writer's experience leads him to believe that both the old-fashioned government regulations giving the same limiting stress for all kinds of loading, and the modern formulæ, based chiefly on Wöhler's experiments, fail to meet the just requirements of the practical engineer. It is in many cases a great economical advantage and convenience to have reference not merely to the variation of stress, but also to the probable number of applications. For example, the writer knows the bending press box girder lever, previously referred to, will last its time although the working stress is about two-thirds of the ultimate strength of the material; and it would have been a mere waste of money to make it four times as strong, and so give it the factor of safety of six; usual and proper enough for a structure such as the "Elevated Railway," of New York, where a practical infinite number of repetitions of stress have to be provided for. Again, in many instances it is preferable to face the fact of occasional breakages than to attempt to give the strength required to insure absolute durability. Thus, in case of railway springs, a fractured leaf is a common and unimportant incident, little to be wondered at, as the working stress often ranges from 60,000 pounds to 80,000 pounds per square inch, on steel having in its tempered condition an ultimate tensile strength of about 160,000 pounds per square inch. If it were as essential to guard against the failure of a spring leaf as it is to guarantee the safety of a railway bridge, it would be necessary to more than double the number of leaves in most springs.

In all works, temporary or permanent, where the stress alternates from tension to compression, large rivet area must be provided, as a very few repetitions suffice to loosen rivets. Where metal has been subject only to compressive stresses of varying intensity, the writer has not so far been able to detect any deterioration, and he takes account of this fact in settling the proper working stress on the struts of bridge trusses and similar works.

Twenty years ago, being uncontrolled by government regulations, the writer adopted a working stress of 16,000 pounds per square inch on many large iron girders carrying a heavy dead load; although at that time a departure from the universal 11,200 pounds per square inch was regarded with suspicion. The results of modern research have, however, now given the engineer a free hand and the British five tons per square inch and the Continental six kilos. per square millimetre have ceased to be regarded with superstitious reverence. A machine or a bridge can only be well proportioned by carefully considering the special conditions of the case, in the light of experimental data and past experience. A string of formulæ will not make an engineer.

In concluding this necessarily very hurried and imperfect paper, the writer would like to bear testimony to the admirable behavior of a very good friend of his—mild steel. During the past three years he has had to deal with about 24,000 tons of that material, and to submit it in many cases to very harsh treatment. He has had more cases of so termed "mysterious fractures" with the few tons of wrought-iron, used for certain temporary purposes, than with the whole 24,000 tons of steel. This rest of his experience may be of interest to brother members of this society who now are, or will

doubtless be, large users of mild steel; and the testimony is perhaps of the greater value as the work at the Forth is pressed on day and night, and no precautions are taken which would not equally be necessary, were the material the highest class of Lowmoor iron, costing double or treble the price of the steel.

Wrought-Iron Conduit Pipes.*

BY HAMILTON SMITH, JR., C. E.

Wrought-iron pipes are largely in use in the Pacific States and Territories of the United States as water conduits: cast-iron pipes are only used for city distributing mains, where frequent connections with service pipes are required. The adaptation of wrought-iron for this purpose was due to the following causes, and affords an apt illustration of the old proverb, that necessity is the mother of invention.

The method of hydraulic mining was introduced or invented in California in 1852. It may roughly be defined as the discharge of jets of water, actuated by gravity with a considerable head, against a bank of auriferous gravel, the water acting first as an excavator and afterwards as a carrier of the washed material The supply of water for these jets at first was conducted through hose made of heavy cotton duck cloth, which was strengthened by outer nettings of cordage when the pressure was large. This hose was costly and short-lived. It was not practicable to use pipes made of cast-iron—first, on account of the prohibitive cost of transportation over steep mountain roads and paths to the mines; and second, because heavy cast-iron pipes could not be cheaply and quickly moved from place to place in the mine, the exigencies of such mining requiring frequent changes in the position of the supply pipes.

In 1853, an ingenious miner laid in his mine a line of pipe consisting of joints of ordinary stove-pipe, made of a very thin sheet-iron, lightly fastened together with cold rivets, with the joints united stove fashion, *i. e.*, the end of one joint being tightly shoved into the larger end of the succeeding joint, with the smaller end pointing down stream. This experimental pipe was some 5 or 6 inches in diameter. The pipe answered the desired purpose admirably, and in a comparatively short time all the many hydraulic gravel mines in California obtained the pressure for their water jets by means of thin sheet-iron pipes. As hydraulic mining increased in magnitude the sizes of these supply pipes also increased, the diameter for main lines for a large mine being from 22 to 30 inches. These pipes, as a rule are made at the mine, the requisite machinery costing less than £100 The iron is from .065 to .134 inch (Nos 16 to 10 Birm. gauge) in thickness, with a double row of of cold rivets for the longitudinal seam when the pressure is to be large. The only test made of the quality of the iron is the judgement of the pipemaker, who can generally discover and reject sheets of bad quality by defects manifested when the plates pass through the rolls; in fact this is one of the chief reasons why the mine owners have preferred to make the pipes themselves. The length of the separate joints is from 18 to 25 feet, one end being slightly smaller than the other end. As a protection against rust each joint is immersed for several minutes in a bath of boiling asphaltum and coal tar; a little resin is added when a glassy surface is desired, and sometimes a little fish oil. This immersion results in a thorough coating of the pipe, both inside and outside, and is vastly superior to any application of paint, When the pipes are coated properly the protection appears to be perfect. The several joints are then joined together, stove pipe fashion, the lower joint being shoved firmly into place by jack screws. When the fit is slack, a piece of tarred canvas is wrapped around the small end; wedges of soft pine wood are sometimes driven in where the fit is a bad one. Such pipes are laid on the surface of the ground, and can be put together or taken apart with great ease and at small expense. When a line of such pipe is laid by skillful men with ordinary care, although the length may be several thousand feet with a pressure at the lower end as great as 450 feet, there are but trifling leaks, which generally can be stopped by putting sawdust into the inlet end of the pipe. As an illustration of the tightness of such rough joints, I may instance a main laid by me for supplying water power, having a length of two miles and a maximum pressure of 550 feet. The leakage from this pipe did not average more than 3 or 4 cubic feet a minute, although the only protection from changes of temperature was a couple of boards tacked together and placed over the pipe.†

After successful practice in the mines had demonstrated the advantages and capabilities of wrought-iron pipes, they were used for permanent conduits both for conducting water to mining districts across deep mountain gorges, and also for the supply of cities. San Francisco, a place of some 300,000 inhabitants, receives its water through two lines of such pipes, and a third pipe, many miles in length and of large diameter, is now being laid for an additional supply.

For permanent conduits the joints of a pipe of considerable diameter are generally riveted together; for small diameters with high pressures lead joints are used. Such conduits are, of course, placed in trenches, and covered with earth in order to avoid excessive alternations in contraction and expansion; slip-joints need not be used, as the pipes are sufficiently elastic to permit changes in length due to variation of the temperature of the water.

The following statement will illustrate the Pacific Coast practice with conduit pipes, the flow in all cases being caused by gravity:—

Name.	When laid.	Length in feet.	Diameter in inches.	Maximum pressure in vertical feet of water.	Maximum tensile strains in lbs. on iron per sq. inch.	Description of pipe.
Cherokee.....	1870	12,798	30	887	17,549	Plate iron double riveted.
Virginia City.....	1872	37,100	11	1,720	about 15,000	Plate iron, double riveted.
	1873	37,100	10	1,720	(?)	Lap welded tubing, outer screw couplings.
Texas creek..	1878	4,439	17	760	about 18,000	Plate iron, double riveted.
Humbug.....	1868	1,194	26	120 (?)	11,500	Single riveted iron $\frac{1}{4}$ inch in thickness; two pipes, each 26 inches diameter, laid side by side.

The two Virginia City pipes are laid side by side; the lead joints for the riveted pipe under the enormous pressure of 1,700 feet, at first give considerable trouble; the lap-welded pipe gave no trouble whatever. The general tensile strain on the Texas creek pipe is about 16,500 pounds per square inch.

The oldest of these pipes—the two across Humbug-cañon—are notable for having been laid seventeen years ago of iron single-riveted only $\frac{1}{4}$ inch in thickness; when I last heard from them, a few months ago, they were reported to be in good order. The other pipes are also stated to be now in excellent condition.

The iron for the Virginia City and Texas creek riveted pipes was of very inferior quality; the iron for the Cherokee pipe was of ordinary quality; yet it will be observed these pipes have for many years past been subjected to tensile strains which must seem almost fabulous to one only accustomed to cast-iron water pipes.

So far as rust is concerned, in my extensive experience I have only seen one notable instance where an asphaltum coating properly applied did not protect the iron, and that was with a pipe over which passed a stream of water highly charged with sulphate of iron. I may also remark that when iron has once been attacked with salt rust from sea water, it seems to be very difficult to prevent further rust.

The California experience with double-riveted pipe, made of a superior article of plate-iron, can thus be summed up:

Such pipes can be with entire safety subjected to a constant maximum tensile strain of 16,000 pounds per square inch.

For a period of twenty years an asphaltum coating has prevented rust, and also the formation of interior tubercles where soft water flows through the pipe.

Lap-welded iron tubes of sizes up to 15 inches in diameter are now largely used in the United States for conduit pipes, and will safely stand a strain of about 20,000 pounds per square inch They are almost exclusively used in the Western mines for pump columns, owing to their combined lightness and strength. The lines of pipe through which petroleum is pumped from the Pennsylvania oil wells to the sea-board are made of this tubing, the diameter generally being 6 inches.

The query presents itself, why should not wrought-iron, still better steel, be used for conduit pipes in preference to cast-iron? If it answers the desired purpose in California, why should it not do so in other parts of the world? To one like myself, who has for years been accustomed to the California practice, it seems as irrational to build a pipe carrying water under considerable pressure of cast-iron, as it would be to build a suspension bridge with the supporting chains made of cast-iron.

Experience in the United States has shown that the practicable limit of size for cast-iron mains is a diameter of about four feet, even when the pressure is less than 100 feet. It is evident that a pipe of wrought-iron or mild steel can be safely made of almost any desired size, and this may be of much advantage if it be desired to conduct a large supply of water through pipes for city or other use. For instance, with an inclination of 3 feet per mile a single pipe 8¼ feet in diameter will carry 280 cubic feet per second, while seven pipes, each 4 feet in diameter, would be required to transport the same quantity of water with the same inclination. The cost of the large pipe, made of steel or wrought iron, would be considerably less than one-half the cost of the seven small pipes made of cast-iron.

The ideal conduit for high pressures is a welded steel tube; such tubes could probably be subjected to a tensile strain of 25,000 pounds with perfect safety, and would be much preferable to riveted pipe, not only on account of superior strength, but also by reason of almost perfect interior smoothness.

It seems to me that this question is well worthy of the attention of British steelmakers and hydraulic engineers. The adaptation of a superior and cheap metal such as mild steel for conduits, will permit the construction of hydraulic works in many parts of the world which now appear to be impracticable, owing to the cost of many of the methods still in use for the transportation of water.

DISCUSSION.

Mr. James Riley, of Glasgow, said that this matter of conduit pipes of steel had been before them for some years. He believed that Mr. Russell Aitken (who spoke on the previous day with regard to the vacuum fan, if they might so term it, for removing blow holes) was at one time resident engineer to the municipality of Bombay, and about twelve years ago he proposed to the authorities there a very extensive water scheme, in which he suggested the water-main of steel. It was the earliest instance that he knew of such a proposal. It was looked upon as a rather mad scheme by a good many people, and hung fire; only this year had the municipality decided to extend its water-works, and had gone in for a cast-iron main, which was taken from a Glasgow firm lately. Some four or five years a paper was read before the Engineers' Institute in Glasgow by a gentleman who had visited the United States; in this paper he detailed a good many of the instances Mr. Smith had laid before the meeting that morning. About four years before he (the speaker) was visited by some gentlemen from New York City, which was the first time that matter had been brought before him. They had under consideration a scheme for laying a water-main to increase the supply of water to New York City. The main was ultimately to be, he thought eighty miles, but at that time it was proposed to be only forty miles. He went into the matter very carefully with those gentlemen, they prepared estimates as to the cost, and made all arrangements for supplying that main, if necessary. About 30,000 tons of steel would have been required. But the scheme had not come to fruition, though at the time mentioned they made under the guidance of one of those gentlemen about a hundred tons of pipe 16 inches diameter, $\frac{1}{4}$ inch thick, which they sent out to Central America for the very purpose which Mr. Smith had laid before the meeting. Subsequently, and just about that time, there was a talk of a large main for New South Wales. He called upon one of the engineers and proposed to him that that main should be made of steel. His firm would undertake to make, ship and deliver it in New South Wales at a considerably lower cost than they could have it made of cast-iron. He believed that eventually a portion of that main was constructed—he did not know whether it was now finished or not—of wrought iron. Following that came the Bombay scheme to which he had referred, and which he had tried to turn in the direction of steel, but had failed. Then, last of all, he had worked in the scheme—the largest scheme heard of in this country, which was settled a few months ago—for a supply of water to Manchester from Thirlmere. He submitted to the engineer in that project a proposal to make that main, which he thought—he should have said that several of those mains were five feet in diameter—bore out what Mr. Smith had said; he suggested that it would be a very much cheaper and more economical scheme for the Manchester Corporation to make that main of steel than to adopt the cast-iron. He had failed in that on one single point. It was nearer being completed than perhaps any of the measures to which he had referred, but it failed because there was no experience as to how the plates would stand in the matter of corrosion. If he could have pointed out to them any experience which would have removed their doubts on that point, or if the engineer would have taken the responsibility, he believed they would have an example in this country of the largest steel main that had ever been constructed. He thought that it would be interesting to the meeting to know how far this had been dealt with in this country.

Mr. Cowper said that at the Kimberley Water-Works there was a main 14 inches diameter of wrought iron welded $\frac{3}{8}$ inch thick. It was eighteen miles long and had turned out to be highly satisfactory. The lift was 350 feet.

†The extreme range of temperature was from 10° to 107° Fahr. (in the shade).

*Read before the Iron and Steel Institute at its London Meeting. May 13, 1886.

Municipal Engineering; Paper No. 4.*

PHILADELPHIA, PA.

Introductory.

(Water With Map.)

Philadelphia, after New York, the largest city in America, is situated on the southeastern border of the State of Pennsylvania, on the fortieth parallel of north latitude, just west of the seventy-fifth meridian, west from Greenwich.

The city embraces the entire county (of the same name), having an area of 129 square miles.

Philadelphia was founded in 1682 by William Penn, who gave it a city charter in 1701, though it was not incorporated until March 11, 1789. The original city had an area of only a little over two square miles, which was not increased until 1854, when "consolidation" with the several outlaying towns was effected, and the limits extended to cover the whole county. Large sections of this area are still open country, covered by farms and exhibiting scarcely an indication of even near proximity to a city.

Many of the smaller villages nearest the original city (which still remains the business center), have been surrounded and absorbed in the spread of population, but several large towns near the remote borders remain as almost isolated groups of population, possessing many of their original individual characteristics, due to peculiar topographical features or habits of their first settlers. These outlaying districts will be referred to more particularly under "Topographical Situation."

The population is now estimated at about one million; it is probably a little less. The growth from the time of settlement to the last census is shown by the following table. Previous to consolidation in 1854, the population given includes the suburban districts but not the whole county with its more distant villages, as since that year. The numbers at some of the earlier dates are estimates.

1683	500	1800	70,287
1684	2,500	1810	96,660
17·0	4,500	1820	114,410
1744	9,750	1830	167,811
1749	13,500	1840	220,523
1753	14,625	1850	360,305
1760	18,656	1860	568,034
1777	23 744	1870	674,022
1783	37,000	1880	846,980
1790	44,996		

The population of the old city proper was about 48,000 in 1808, and 121,000 in 1850.

Density of Population.—The population is nowhere very dense compared with other great cities, the average number of inhabitants in the most densely populated ward in 1880, having been 135 per acre, which probably does not differ much from the present number. For smaller divisions than wards the maximum density is somewhat greater, but probably not over 175 per acre for a whole square. The average population in the built-up residence portion is perhaps 120 per acre.

This comparative sparsity of population is due to the early habit, still continued to a great extent of building low houses, often only two stories, and the almost entire absence of "flats." Tenement houses are supposed not to exist at all in Philadelphia, and perhaps there are none built for this purpose, but according to civil engineer William Henry Baldwin, in his elaborate report on the "Sewerage and House Drainage of Philadelphia," prepared for the United States census office, "hundreds of large buildings once the residences of wealthy and aristocratic citizens have passed through the usual stages of fashionable and unfashionable boarding house, the cheap lodging house, and now differ from the tenement house only in name." This, however, exists only in the old and most crowded parts.

The following table shows the number of dwellings of the various sorts, (classified according to material and number of stories) in 1885.

Brick, one-story	504
" two "	49,628
" three "	89,703
" four "	6,680
" five and over	715
Total brick	147,230
Stone, one-story	176
" two "	4,604
" three "	5,017
" four and over	204
Total stone	10,001
Frame, one-story	377
" two "	9,171
" three and over	2,903
Total frame	12,451

Grand total 169,682 dwellings in January, 1885.

As will be seen nearly all are of brick. In the city proper they are so almost exclusively, the stone dwellings being mostly in West Philadelphia and Germantown, and the frame in rural portions.

The prevailing style of dwelling has its first floor 2 or 3 feet above the street, with only a cellar below it. Basements partially above the street as in New York are rarely found. Entrance to the rear of dwellings built in blocks is had through a narrow passage way one-story high, serving two houses, or from an alley in the rear running between two rows of houses. In some sections brick dwellings built in the same general style as those blocks are divided up in pairs, with a space wide enough for a walk on each side of a partition fence. In the more open portions as in West Philadelphia and Germantown, dwellings are generally constructed in pairs at a greater distance apart, especially those of stone. Few dwellings, except the most pretentious, are isolated.

Another peculiarity of Philadelphia is the great number of building associations whereby people of moderate means become owners of the houses they live in, so that the common remark that "every man in Philadelphia owns his own house" is not far from the truth, excepting the very poorest of the population.

The dwellings of the common people are also better provided than in other cities with conveniences, especially baths, which number over 70,000, or an average of nearly one for every two houses—more, it is said, that in any other city in the world.

Topographical.—The city is bordered on the southeast for about two and one-fifth mile by the river Delaware, which is the boundary between the States of Pennsylvania and New Jersey. The Schuylkill, entering the city from the northwest, flows through it to the Delaware in a generally southern direction, forming a peninsula six miles long and from two to four miles wide. The southern end is low alluvial land, slowly rising toward the north. The greater portion of the old city (which remains the business center), occupying the narrowest portion between the rivers, is from 20 to 40 feet above sea level. In the northwestern section of the built-up portion of the main city an elevation of about 100 feet is reached which is not generally exceeded in the large northeastern area, mostly rural, where the slopes are very gentle; but toward the northwest in the Schuylkill watershed, the surface becomes undulating and rapidly rises, reaching 300 feet in Germantown and about 450 feet at Chestnut Hill, near the northwest boundary. The slopes to the water-courses in this section are quite steep, even precipitous along the Schuylkill and its tributary Wissahickon creek which drains the southern slopes of Germantown and Chestnut Hill. By far the greater portion of the area between the two rivers is in the Delaware watershed, the dividing ridge in the northern portion being much nearer the Schuylkill, the steep descent to which, though gradually becoming shorter, remains quite prominent to the narrowest part of the peninsula. West Philadelphia is more undulating than the opposite portion of the main city, though similar to it in rising toward the northwest. The southern portion, which is sparsely settled, is quite low, but most of the more densely populated part has an elevation of from 40 to 100 feet.

The streets are all straight and on the rectangular system, except a few old country roads. There are at present about 580 miles of paved streets, fifty miles of macadamized and 450 miles of unpaved streets. The longest straight street is Broad, 113 feet wide, running north and south through the heart of the city; it is laid out to extend from boundary to boundary, a distance of eleven miles, but the upper two miles are not yet opened. Two or three crooked old turnpikes bear the same name for about ten miles each.

One public park, Fairmount, having an area of nearly 2,800 acres, is situated on both sides of the Schuylkill, northwest of the heart of the city, with a narrow strip extending up the river to the mouth of Wissahickon creek and thence up that stream on both sides to the city limit, some six miles beyond the park proper. Its natural topography is finely adapted to the purpose, containing a pleasing diversity of gentle slopes and rugged steeps. Besides this great park there are several small squares (of five or six acres each) in the heart of the city.

Climate.—The average mean annual temperature of the last nine years, as recorded at the Philadelphia station of the U. S. Signal Service, has been 53.7° Fahr. The ordinary range is from 0° to 95°. Only a few times in an average winter does the temperature fall below zero and then ordinarily only two or three degrees. The frost penetration seldom, if ever, exceeds 3 feet and in the heart of the city is usually not more than six inches below the paving stones. The average annual rainfall for the last nine years at the Signal Service station, was 36.66 inches, the greatest amount being 45.58 (in 1882) and the least 30.21 (in 1881). During this same period the maximum fall in twenty-four hours was 4.78 inches, the next largest being only 2.86 inches. Records at the Pennsylvania Hospital from 1816 to 1876 show the greatest precipitation in any year of that period to have been 61.19 inches (in 1867) and the least 23.35 (in 1819). In the last seventy-five years the rainfall has increased at an average annual rate of about three tenths of an inch, with but little if any increase of the summer rainfall. The tide in the rivers rises and falls about 6½ feet. In the Schuylkill it is stopped just above the heart of the city by Fairmount dam, the water above which furnishes the public supply.

(TO BE CONTINUED).

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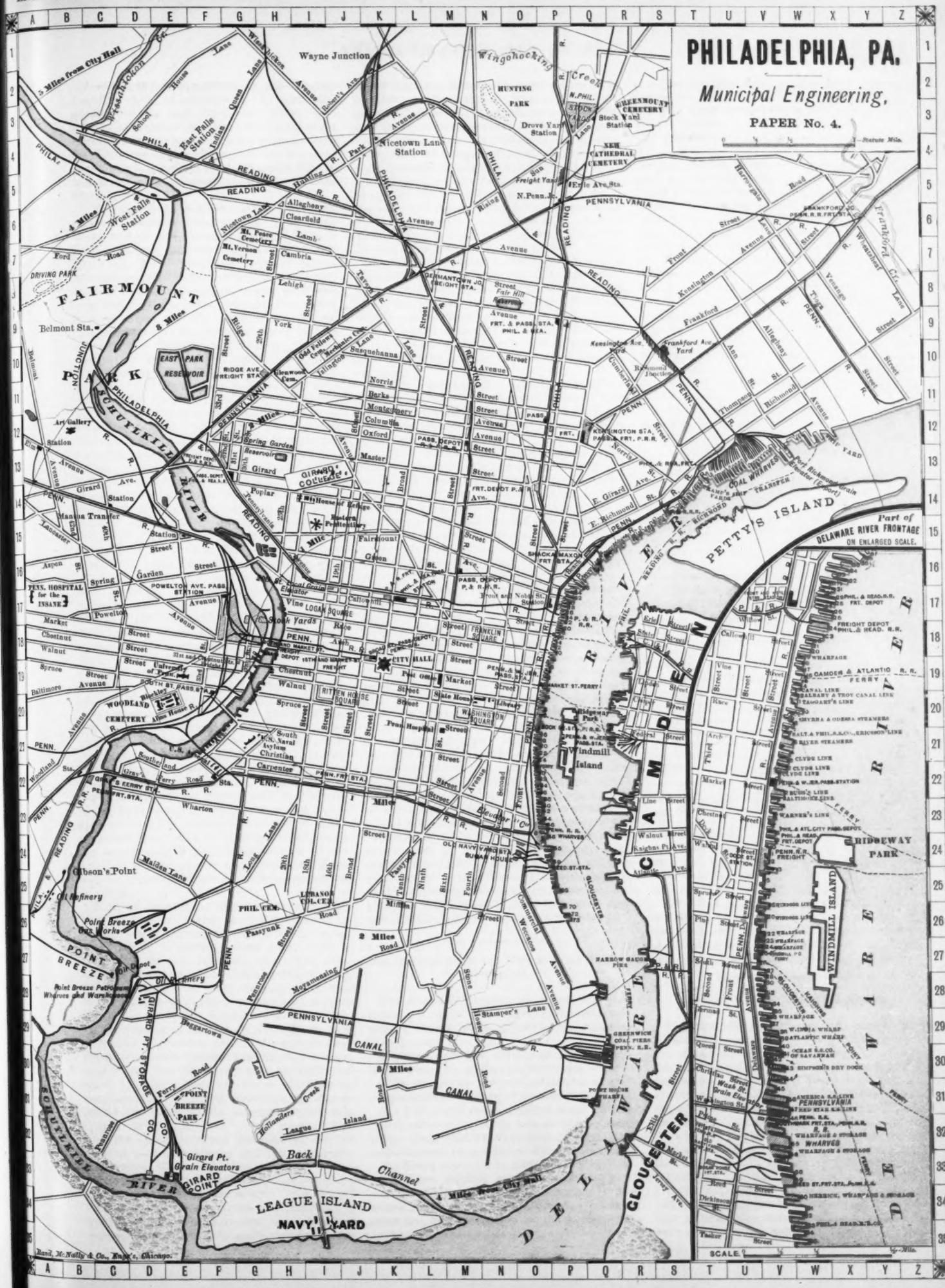
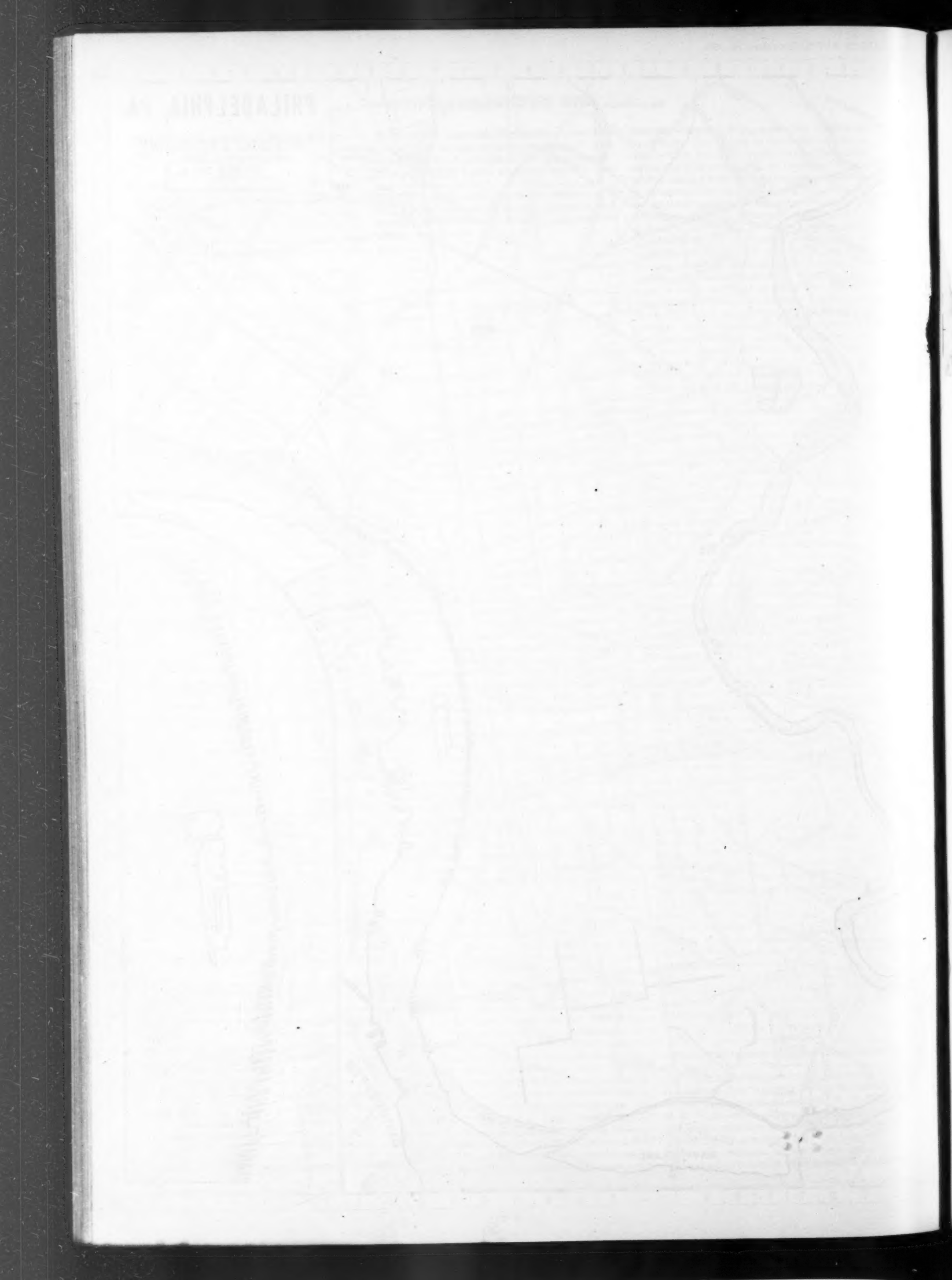
Electric Induction between Wire and Wire.

A remarkable paper with the above title was read at the late meeting of the British Association at Birmingham, by Mr. W. H. Preece, F. R. S., in which some extraordinary instances were mentioned of the effect on telephones caused by telegraph wires acting from various distances. Several cases were mentioned which had previously been given in evidence


PHILADELPHIA, PA.
Municipal Engineering.
PAPER No. 4.
Statute Mile.
Wayne Junction
Wingohocking Creek
HUNTING PARK
Nicetown Lane Station
Drove Yard Station
Stock Yard Station
GREENMOUNT CEMETERY
NEW CATHEDRAL CEMETERY
Erie Ave. Sta.
N. Penn. Jc.
PENNSYLVANIA
READING
PHILA.
Allegheny Avenue
Westmoreland Street
Cambria Street
Lehigh Avenue
York Street
Girard Avenue
Spring Garden Street
Poplar Street
Fairmount Avenue
Vine Street
Callowhill Street
Market Street
Chestnut Street
Walnut Street
Spruce Street
Pine Street
Lombard Street
South Street
Carpenter Street
Wharton Street
Passyunk Road
Moyamensing Avenue
Penrose Ferry Road
Girard Avenue
Frankford Avenue
Kensington Avenue
Front Street
Richmond Street
Thompson Street
Ann Street
Tioga Street
Venango Street
Westmoreland Street
Frankford Creek
Frankford Jc.
Harrowgate Road
Wissahickon Creek
Lancaster Pike
Belmont Sta.
Art Gallery Station
West Falls Station
East Falls Station
DRIVING PARK
FAIRMOUNT PARK
EAST PARK RESERVOIR
RIDGE AVE. FREIGHT STA.
Mt. Peace Cemetery
Mt. Vernon Cemetery
Odd Fellows Cem.
Monteflores Cem.
Lafayette Cem.
Ridgewood Cem.
Girard College
Mill House of Refuge
Eastern Penitentiary
Masonic Cemetery
Woodland Cemetery
Almshouse
Lunatic Asylum
Penn. Hospital
Penn. Hospital for the Insane
Powelton Ave. Pass. Station
Manayunk Transfer
Schuylkill River
Delaware River
Camden
Petty's Island
Part of Delaware River Frontage on Enlarged Scale.
Windmill Island
Ridgeway Park
Kaighns Pt.
Gloucester
Kaighns
Harrow Gate Pipes
Greenwich Coal Piers
Penn. R.R.
Gibson's Point
Oil Refinery
Point Breeze Gas Works
Point Breeze Petroleum Wharves and Warehouses
Point Breeze Park
Girard Pt. Storage Co.
Girard Pt. Grain Elevators
Girard Point
League Island
Navy Yard
Back Channel
Hollanders Creek
Stamper's Lane
Commercial Wharves
Old Navy Yard Sugar House
Penn. Fruit Sta.
Broad Street Sta.
Reading Terminal
City Hall
Post Office
Public Buildings
Franklin Square
Logan Square
Washington Square
Rittenhouse Square
Stock Yards
Coal Wharves
Pier Richmond Grain Elevator (Export)
Shackamaxon Frt. Sta.
Kensington Sta. Pass. & Frt. P.R.R.
Frankford Ave. Yard
Kensington Ave. Yard
Richmond Junction
Delaware Ave. Yard
Germantown Jc. Freight Sta.
Fair Hill Avenue Frt. & Pass. Sta. Phil. & Rea.
Callowhill Street Pass. & Frt. Sta. Phil. & Rea. R.R.
Pass. Depot P. & R. R.R.
Pass. Depot P.R.R.
Frt. Depot P.R.R.
Pass. Depot Phil. & Rea. R.R.
Pass. Depot Phil. & Erie R.R.
Pass. Depot Phil. & Read. R.R.
Pass. Depot Phil. & Balt. R.R.
Pass. Depot Phil. & Trenton R.R.
Pass. Depot Phil. & Atl. City R.R.
Pass. Depot Phil. & Camden R.R.
Pass. Depot Phil. & Wil. R.R.
Pass. Depot Phil. & Del.



efore the Select Committee on the Electric Lighting Acts, of interference between telegraph circuits and telephone wires. One particular instance was that of telephone wires running over the tops of the houses in London for a distance of 2½ miles, and along the same route was an underground telegraph line in iron pipes, at a distance below the telephone wires of 80 ft.

"The telephone company stated that they observed certain disturbances upon their wires, and on one occasion had been able to read a message that was sent from London to Bradford. Now, inasmuch as the Bradford wire passes through these pipes, it was clearly evident that the disturbance, such as it was, was due to some action between the underground wires and the overground wires." Every precaution was taken in subsequent experiments to eliminate any possible chance of conduction, and the result was that it became clear that the disturbances were due to "induction." As the distance between the wires was greater than could be imagined for the efforts of induction to show itself, subsequent experiments were tried on the Town Moor, at Newcastle, to determine at what distance the induction between wire and wire could be traced, when" it was found that distinct evidences of induction were felt at a distance of 3,000ft." Some further trials were made on a telegraph line situated between two other lines, 5¼ and 10¼ miles away, and signals were distinctly perceived when a transmitter was sending on the central line. "This experiment took place on Sunday. The lines were isolated at each end, and while everything was perfectly quiet—while the distinctive currents produced by the transmitter were absent— the observers received distinct indications of Morse signals being sent elsewhere. There was no line near, there was no place where these Morse signals could be obtained but from a line on the other side of England, 49 miles away from this particular place." In a further test, taken with every precaution, similar results were observed, and the author states that "the conclusion we come to is that an inductive effort took place across this country 49 miles broad." But although every precaution was taken in these experiments, they were compelled to use the earth as part of the circuit, and Mr. Preece says "I am bound to say that there are many reasons why the evidence must not be taken as conclusive," and he continues "although the experiment is very interesting, I do not say that it is conclusive that inductive effects can be transmitted across such an extent of country."

With an instrument of such extreme delicacy and sensitiveness as the telephone to make such experiments conclusive, the use of earth must be entirely done away with, a matter of extreme difficulty, as, without considering the earth connections at the ends of the wire, there is at every support along the line a leakage to earth, small indeed at each particular point, but large in the aggregate. In the discussion which took place, Professors Sylvanus Thompson and Blyth agreed that the phenomenon described might, to a certain extent, be due to conduction through the earth. But in a most important experiment, mentioned in this paper, Professor Thompson stated that there was no possible explanation "save true induction," but where they had the earth between; he believed the far greater part was simply leakage, otherwise conduction, through the earth.

The experiments alluded to is unique of its kind, and perfectly conclusive. "A circuit was made of gutta-percha covered wire a quarter of a mile square—that is, a circuit of copper wire covered with gutta-percha laid on the ground in a square of a quarter of a mile. Another similar square was laid on the ground." The result of this experiment we give in the author's words :—"But the result I have got is this—that, with a square fixed at a distance of a quarter of a mile from an exactly similar square, it is quiet possible with a telephone in one square to speak to a telephone in the other square, separated by a distance of a quarter of a mile. There is no earth there; there is no disturbance; there is nothing that could possibly enable a listener in one telephone, to hear a speaker in the other telephone except inductive effect across that layer of air a quarter of a mile in length." These experiments are of a most interesting character, and we are glad to learn that they will be exhaustively carried out, and, as the mathematical assistance of Lord Rayleigh will be obtained, the results in the future will prove, doubtless, of the greatest practical advantage.

In this paper and discussion the practical question of these disturbances between wire and wire was not lost sight of, and the only cure given as certain was the use of two wires forming a metalic circuit.

"The cure for these disturbances," Mr. Preece remarks, "between telegraphs and telephones was as simple as possible—namely, to invariably use a metallic circuit. Why telephone companies had been so foolish as to exercise the false economy of depending upon single wires was one of those puzzling things which were not possible of explanation. In the Post Office, as soon as they were perfectly satisfied that induction was the main cause of the disturbance, they decided to use double wires, and they never used anything else anywhere." We have heard remarks made as to the competition between the Post Office and the telephone companies, and that the former are taking away the proper business of the latter, but can it be wondered at, when the service performed by the Post Office is better, and freer from disturbances, which are at times prohibitory to conversation. We are aware that many persons decline being put on a telephone line where other wires exist, from the fact that the private conversations of others are heard, and with the certain knowledge that their own private business would be equally heard by those in the same branch of commerce as themselves. Were the telephone companies to study more deeply the interests of those to whom telephonic communication is of absolute necessity, and provide them with lines free from interference and what is termed "crosstalk," the number of subscribers would rapidly increase, and the ultimate result would prove increased dividends accompanying general satisfaction.

Russian Rules for the Use of Steel in Construction.

The Russian Ministry of Roads has published a series of provisional regulations concerning the use of steel, of which the following is a summary:

1. Steel, whether Bessemer or Siemens-Martin, may be used in all structures.

2. In view of the great sensitiveness of steel to mechanical working, it is to be noted that:

(*a.*) Plates and other sections must be tempered, after rolling, by means of the sand-bath. Care must be taken that on leaving the rolls the metal is not below a cherry-red heat.

(*b.*) Holes must not be punched, but drilled.

(*c.*) When worked cold, the material must not be sheared, but cut with a chisel. The edges must be planed. All boring must be done hot, and provision be made for subsequent slow cooling.

3. The material must possess the following properties:

(*a.*) It must contain from 0.05 to 0.20 per cent. of carbon.

(*b.*) Except for rivets, the tensile strength of all kinds of steel must be from 25.4 to 29.8 tons per square inch, extension at least 18 per cent., and the contraction of area at least 36 per cent.

For rivets, the tensile strength must be from 22.2 to 25.4 tons per square inch, extension at least 20 per cent., and contraction of area at least 50 per cent. The percentage of carbon for rivets must approach the lower limit (see *a*). Extension and contraction of area are to be measured on test pieces of 10 inches in length. The test pieces must be worked cold.

4. A strip of the metal 10 or 12 inches in length, heated to cherry-red, and then plunged into water at 85½ degrees Fahrenheit, must not show any cracks when so bent that the inner faces of the bent piece, at a distance from the angle of one-and-a-half times the thickness of the plate, are three times the thickness of the plate apart.

5. The permissible strain upon the material is as follows:

(*a.*) For bridges of less than 49 feet span, and also for roadway-bearers (longitudinal and cross:

	Tons per sq. inch Steel.	Iron.
For tension and compression	4.4	3.8
Shearing of rivets, fastening the longitudinal to the cross-bearers, and these to the main girders	3.8	3.2
Shearing of rivets in the rest of the structure	4.4	3.8
Shearing of the web of a plate-girder	2.9	2.2
(*b.*) For main girders of bridges of from 49 to 95 feet span:		
Compression (after deducting half area of rivet holes)	4.8	4.4
For tension (net cross-section, after deducting rivet-holes)	4.8	4.4
Shearing of rivets	4.4	3.8
(*c.*) For main girders of bridges of more than 95 feet span:		
Tension (net cross-section, after deducting rivet-holes)	5.1	4.6
Compression (after deducting half area of rivet-holes)	5.1	4.6
Shearing of rivets	4.4	3.8
(*d.*) For wind-bracing of bridges of more than 95 feet span:		
Tension (net cross-section)	6.3	5.7
Compression (after deducting half area of rivet-holes)	5.7	5.7
Shearing of rivets	5.1	4.8

Iron and steel may be used in the same structure, but with the limitation that in each member of a group of similar parts the same material is to be used. For instance, the top and bottom booms of a girder form such a group; the diagonals and verticals of a girder, the cross and longitudinal roadway-bearers, are other such groups. The use of steel rivets is not compulsory with steel plates.—*Iron.*

Lower Thames Valley Sewerage.

The engineering scheme by which Mr. Mellis, C. E., porposes to deal with the sewerage of the Lower Thames Valley, or at last that part of it comprised in the parishes of Richmond, Mortlake, Kew, Barnes and Petersham, appears to be more extensive and important than has generally been recognized. Hitherto unpublished details were laid before Mr. Arnold Taylor, at Richmond, when he held a Local Government Board inquiry into the application of the Urban and Rural Authorities of the Richmond Union to borrow, for the purposes of the scheme, the sum of £100,000. It appears that the sewage from the district interested enters the Thames by some twenty-five outlets, and it is intended by the

scheme to intercept all this and to prevent its discharge into the Thames. The new sewers are designed to serve a possible future population and to convey the sewage proper in twenty-four hours, and they have a discharging capacity, if running full during twenty-four hours, at the rate of 10,912,180 gallons. All the sewers will have self-cleansing velocities, varying from 2 feet to 3 feet a second when running a third full. They will be almost entirely built in tunnel in the London clay by means of shafts averaging about seventy yards apart, and each shaft being made with a manhole.

The total length of sewers is 7,971½ yards, and the cubical contents about half a million gallons. With a velocity of 2 feet per second, the sewage from the most distant parts of the district would take three hours to arrive at the precipitation works. The sewage will be brought by gravitation to the pump-chamber at one of the precipitation works. The floor of the pump-chamber is 25 feet below datum, and 37 feet below the surface of the ground. From this chamber the sewage would be lifted by pumps a height of some 40 feet into the works and tanks. Provision is made for pumping at the rate of 8,068,580 gallons in twenty-four hours, and the pumping power provided is 114 horse. It is intended to set up three compound, horizontal, condensing engines, with three sets of pumps, each set to consist of two single-acting pumps. The pumping machinery gether is capable of lifting at the rate of 13,000,000 gallons in twenty-four hours, or 2½ inches of rainfall in twenty-four hours.

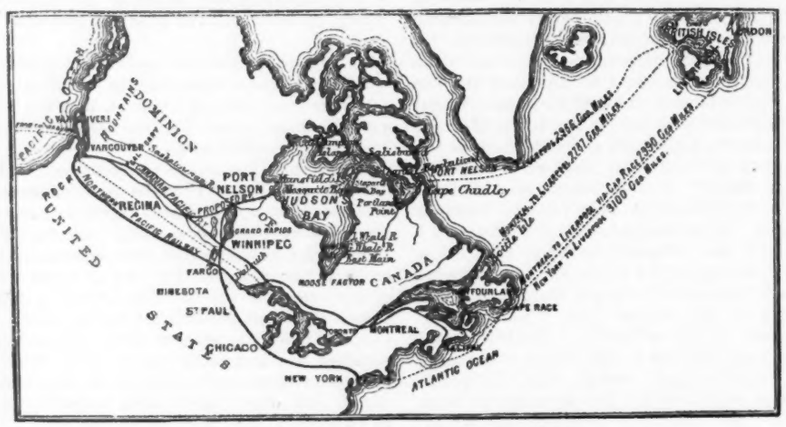
The site of the precipitation works contains about eleven acres, of which the necessary buildings cover three and a-quarter acres. The works will be raised one foot above the highest flood level of the Thames, and the following machinery is provided for:—Three sets of engines and pumps, three boilers, each 100-horse power; two 10-horse power steam engines, to work singly or together; two steam pumps of 14-horse power, to lift effluent water; and efficient modern sludge-pressing machinery, including three 30-chamber 36in. square presses; one set of hydro-pneumatic forcing receivers; one sludge pump; one air pump; one steel air receiver, and other pieces of machinery. The sewage will be treated with chemicals, mixed, strained, and passed to precipitation tanks with a capacity for 1,210,000 gallons. The effluent water is to be throughly filtered, and then discharged into the Thames. The resultant sludge, which will be delivered from the presses in the form of solid cakes, will be utilised for manurial purposes. It is estimated that the pressed sludge will amount to about nine tons per day. As a further indication of the importance of the scheme it may be mentioned that the sewers and manholes will cost over £35,000, and the pumping station £13,680. The total cost of the scheme is within about £20 of £100,000; out of which sum £12,500 is for land compensations. It is estimated that the total annual expenses will require a rate of about 6½d. or 7d. in the £. The promoters desire the repayment of the whole loan to be spread over a period of sixty years. The decision of the Local Government Board is anxiously awaited by a population of about 50,000, who, after many unsuccessful efforts in a similar direction, look to this latest engineering project to put their district into a decent sanitary condition.—*The Engineer.*

Apartment House.—The contracts are being let for the large apartment house to be erected on the Ogden block, on the north side, Chicago, to cost about $800,000. This structure which has already been mentioned in our columns, will be called the "Lafayette Place mansions" and will be a very imposing structure. W. W Clay, 178 Dearborn street, architect.

The Hudson Bay Railway.

Among the lines authorized by the Canadian Parliament, and now in course of construction in northwest Canada, there is one known as the Winnipeg & Hudson Bay Railway, which has already attracted some attention and is likely to assume considerable importance if its promoters are successful in their object of developing and improving the old Hudson's Bay trade route to Great Britain. This route has been successfully used by the Hudson's Bay Company for over 250 years, and was—until recently—the only means of communication with their numerous trading posts on the prairies; and if the number of vessels sent out by the company to Hudson's Bay is less now than it formerly was, it is because since the establishment of railways to the south of Manitoba it costs them less to export by this route a great portion of the goods that they formerly despatched by way of York Factory, via Hudson's Bay. By the authorized line of railway above named it is proposed to connect Regina, its western terminus, and Winnipeg, its eastern—both on the Canadian Pacific Railway—with Port Nelson. The projectors claim for their route, which is shown on the accompanying map, enormous savings in distance by railway, while the distance by sea is practically the same as by other routes. The savings in railway transit by the Hudson's Bay route to Liverpool are given as follows:—From Winnipeg, over Montreal route, 775 miles; from Winnipeg, over New York route, 1,129 miles; from Winnipeg, over Halifax route, 1,618 miles; from Regina, over Montreal route, 1,081 miles; from Regina, over New York route, 1,435 miles; from Regina, over Halifax route, 1,924 miles. As to the navigation, the projectors are supported by the most recent reports of evidence collected on the subject by the Dominion Government from their own agents, stationed at various points on the straits and bay. They say on this authority that navigation for ocean steamships will be open in the straits for at least four months, and frequently for six months of the year; that the harbour selected near the mouth of the Nelson river is never closed by ice, and that the river itself has a tidal navigation of twenty-five miles.

As an advantage of detail, referring to the nature of the trade expected, it is pointed out that in the summer season the new route will be cooler, and that this peculiarity, added to the saving in distance, will tend to secure for it a large share of the meat and grain traffic from the United States as well as from Canada, because both of these classes of exports are benefited by a certain degree of cold. The line of railway—which has a total length of about 950 miles—is intended to follow the line of the Hudson Bay Company's trade route from Port Nelson to Lake Winnipeg, and by its western coast to reach the city of Winnipeg—the capital of Manitoba—and the famous Red River valley. The western branch, separating at Grand Rapids, will serve Regina, the capital of the northwest territory and the center of the fertile belt. A considerable traffic is also anticipated by reason of the facilities which the railway will afford for the development of the fisheries of Hudson's Bay, which are known to be extensive. The whole line, for the purposes of construction, is divided into three sections:—From Regina to Grand Rapids, 300 miles; from Winnipeg to Grand Rapids, 250 miles; and from Grand Rapids to Port Nelson, 400 miles. No particular engineering difficulties are anticipated, and only a small portion of the line traverses a rocky district, the remainder being located in prairie land or easy country. The sections throughout have been laid out with the view of economising works. Some large timber trestle bridges of the Howe truss type will, however, be required to bridge the gorges in which the rivers run. The railway throughout, both in works and permanent way, will be built to the same excellent standard as that of the Canadian Pacific Railway; and it is satisfactory to learn that the works in connection with the section immediately north of Winnipeg are now in progress and are being vigorously prosecuted, a shipment of 4,400 tons of steel rails from England having been already made, whilst about forty miles of the line have been graded. Provision will be made along the route and at Port Nelson for the storage and rapid shipment of large quantities of grain, and for this purpose grain elevators constructed on the model of those already in use on the Canadian Pacific Railway and in the United States will be erected. The Provincial Government of Manitoba, as an evidence of the keen interest with which the undertaking is regarded in the northwest, has given a guarantee to assist in the execution of the works, and the Dominion Government has reserved a magnificent area of 8,400,000 acres from the Crown lands adjoining the railway as a subsidy or free gift. The contractors for the construction of the line have had considerable local experience, having been engaged upon the works of the Canadian Pacific and other railways in Canada. The consulting engineers of the company are Sir F. J. Bramwell, F. R. S., and Mr. W. Shelford.—*The Engineer.*



MAP SHOWING PROPOSED HUDSON'S BAY RAILWAY.

Elevators.—The Lake Superior and Union Elevator Companies will erect two very large elevators in Duluth, Minn., having a capacity of about 4,000,000 bushel each. Work is to be commenced at once. The Sawyer syndicate will also erect three new elevators in the same city, which will double the elevator capacity there

The New Belgian Congo Company.

The list of directors of the new Belgian Congo (Railway) Co., to be submitted for approval at the first general meeting, has been published in the Belgian papers, and will interest our readers as an indication of the constitution of the company. It is as follows:—M Jules Urban, director-general of the Belgian Grand Central Railway; M. Simonis, manufacturer, of Verviers, and member of the Belgian Senate; M. Meeus, manufacturer, of Antwerp, and member of the Chamber of Deputies; M. de Burlet, barrister, of Nivelles, and member of the Chamber of Deputies; M. Auger Vincent, manufacturer, of Ghent; M. de Roubaix, manufacturer, of Antwerp; M. Auguste de Laveleye, general secretary of the International Railway Commission; M. Valére Mabille, iron manufacturer, of Morlanwelz; M. de Bary, shipowner and representative of the North German Lloyd's Steamship Company at Antwerp; Captain Thys, of the Belgian Artillery. The president is yet to be nominated, and the list will be increased, it is stated, later on by the addition of several foreign directors.—London *Financial News*.

Coast and Geodetic Survey.—The annual report of F. M. Thorn, Superintendent of the Coast and Geodetic Survey, has been laid before the House. Special reference is made to important investigations in terrestrial magnetism, physical hydrography and geographical history. The aggregate of the estimate for the next year ($560,675)is, the Superintendent says, considerably larger than the appropriation for the current year, but is less than the average appropriation for many years past. The increase relates only to field expenses and is accompanied by a proposed decrease of $7,093 in salaries, thus contemplating the accomplishment of more work for less pay. Among the appendices, which treat of matters of more than local interest, are those relating to the advance toward completion of the resurvey of New York Bay and Harbor, to the studies of ice formation and movement in the Delaware river and bay, and to the observation of currents in the Gulf Stream.

Cement Setting.—According to experiments detailed by E. Michel, the setting of cement is dependent, firstly, on the addition of water, which should be as limited and uniform as possible; secondly, on the density and intimate mixture of the materials; and, thirdly, on the formation of calcium carbonate. Of the three principal constitutuents of cement, silica, lime and alumina, all are chemically active, but the proportion of lime need only be slight; the alumina determines the rapid setting, but the silica the permanent hardening. The chemical change which conditions the setting only takes place to a slight degree, and is principally restricted to the surface. Analyses are given to prove that on an average not more than 5 per cent. of the material becomes chemically combined. The alkalies play on important part in the setting.

The Poughkeepsie Bridge.—The concrete foundation for Pier No. 6 has been completed and work has been commenced on the masonry; concrete is rammed in between the pier and the solid rock. The stone is limestone, and was brought to the site by the former contractors. The concrete is mixed with hot water to prevent it from freezing. The anchorage excavations are completed. Operations on the river piers have been considerably interfered with by floating ice. Messrs. Brock and Gibson, of the Manhattan Bridge Co., and P. P. Dickinson, Chief Engineer, have recently inspected the work in progress.

Engineers' Club of Philadelphia.

Record of business meeting, December 4, 1886. President Washington Jones in the chair; 24 members present.

Mr. Carl Hering read a paper upon Analogies between Electrical and Mechanical Units and Phenomena.

The Secretary presented, for Mr. A. H. Howland, a paper upon the general subject of Water Pipes.

As to cast-iron pipes—after considering, at length, the various questions and conditions affecting their proper thickness, the author says:—"In relation to the strength of pipes, it is a simple matter to calculate the resistance of a perfect cylinder, made of a certain quality of material, against an internal pressure; but until you are willing to pay a fair price and insist upon good material and good workmanship, we must pay for an excess of material sufficient to insure us against the poor quality of the material and the carelessness of the workmen. Just what per centage to add to the minimum thickness of pipe, for all these things, is a little uncertain, but, from a careful examination and study of all the data obtainable from 500 different works in the United States and Canada, I have concluded that,—for all we have to guard against, either in quality of material, carelessness in manufacture, carelessness in handling or laying, or against water hammer,—a factor of safety of five is ample, and this only on the larger pipes.

"At the present time it is perfectly feasible to obtain pipes of material having a tensile strength of 18,000 pounds to the square inch, and, with such material, the minimum thicknesses of various sizes of pipe, together with their weights and ultimate strength, are as follows:

Internal diameter.	Minimum thickness.	Weight per ft. of cylinder.	Weight per ft. of pipe laid, including bells.	Weight per length to lay 12 ft., including bells.	Ultimate strength if made of 18,000 lb. iron.	One-fifth of the ultimate strength.
4	0.32	13.57	14.67	176	2880	576
6	0.35	21.82	23.83	286	2100	420
8	0.37	30.43	33.00	396	1665	333
10	0.40	40.83	44.33	532	1440	288
12	0.45	55.00	59.83	718	1350	270
14	0.47	66.76	72.75	875	1210	242
16	0.50	80.99	88.42	1061	1125	225
18	0.52	94.54	102.25	1227	1046	208
20	0.55	110.95	117.92	1435	990	198
24	0.60	114.89	156.50	1875	900	180
30	0.70	210.97	227.00	2724	840	168
36	0.80	289.04	310.75	3729	800	160
40	0.85	340.87	369.25	4431	765	153
42	0.90	379.03	410.58	4927	770	154
48	1.00	481.02	521.08	6253	750	150

After discussion of the above figures and of the facility with which he considers a 6-inch pipe of but $\frac{3}{16}$ inches in thickness can be successfully tapped for service connections, the author proceeds: "In the reports from 38 different places using 24-inch pipes under various pressures, I find one place using pipe weighing as light as 182 pounds to the foot, which would be about $\frac{7}{16}$ of an inch in thickness; while another works, under the same pressure and probable circumstances, use pipes weighing 306 pounds to the foot, or about 66 per cent. in excess of the lighter. I do not know that I have strength of conviction enough to advocate the use of 24-inch pipe only $\frac{6}{16}$ of an inch in thickness, for any works where there is any pressure at all, although my estimates and figures show that it would be perfectly safe, but, it is so radically different from custom, that I have, to a certain extent, given way to custom and prejudice and have adopted as standard weights for all pipes used in works contracted for by myself, as follows:

Internal diameter.	Thickness, inches.	Weight per ft. of cylinders.	Weight per ft. of pipe laid, including bells.	Weight per length of pipe to lay 12 ft.	Ultimate strength when made of iron having tensile strength of 18,000 lbs.	One-fifth of the ultimate strength
4	0.40	17.27	18.75	225	3600	720
6	0.42	26.46	28.92	347	2515	503
8	0.45	37.33	40.50	486	2025	405
10	0.50	51.54	56.17	673	1800	360
12	0.55	67.76	73.75	885	1650	330
14	0.58	83.02	90.67	1088	1490	298
16	0.60	97.78	106.78	1281	1350	270
18	0.64	117.11	126.67	1520	1280	256
20	0.70	142.25	153.43	1841	1260	252
24	0.80	194.77	210.33	2524	1200	240
30	0.90	273.00	285.33	3824	1080	216
36	1.00	363.22	390.50	4686	1000	200
40	1.10	443.82	480.83	5770	990	198
42	1.16	491.49	532.42	6389	995	199
48	1.30	629.16	681.58	8179	975	195

Cement lined pipes, so-called, are next discussed. Their mileage is given as next to that of cast-iron, and the attractive feature of their cheapness in first cost noted. As to the results of their use the author says:—

"Three years ago I sent personal letters to every department whose address I could obtain, throughout the United States and Canada, that had ever used wrought-iron cement lined pipe, and received a very large number of replies. From a careful study of these replies, I find that the average life of the cement pipe, as usually made, was eight years, and that no place, with two exceptions only, who had had these pipes in use for a longer period than eight years, recommended them.

"The objection to this class of pipe is: first, cement mortar, composed of one-half sand and one-half cement, is not an impervious material, and water, under ordinary pressure, is forced, to a greater or less extent, through it, and so comes in contact with the shell, which it eats until it has no strength left, when the pipe is destroyed. In examining many miles of this pipe which has been taken out and replaced with cast-iron, I have noticed that wherever a joint was made and covered with neat cement, the iron has been in almost as good condition as the day the pipe was laid, and this gives rise to the belief that a wrought-iron shell, lined and coated with neat cement, would have greater durability and life than one lined and coated with cement mortar. Whether such a pipe can be perfectly made or not is a serious question, and is the only question which prevents a much larger and more general use of this kind of pipe. The many manipulations necessary before the pipe is complete in the trench, and the fact that both the lining and coating depends, for its efficiency, upon the manipulation of mechanics, allows too many possible mistakes or errors to creep in and so render the pipe imperfect."

Wrought-iron coated pipes are next considered, with their advantages, and the objections thereto on the score of durability, with the various processes which have been devised for their preservation. The author says: "It is my opinion that wrought-iron pipes treated in some one of the methods indicated, or in some method yet to be discovered, will soon supersede, in most cases, all other kinds of pipe."

Wooden, earthenware, composition, and glass pipes are noted in concluding the paper. All but the latter the author treats as of little general importance. As to glass pipes, he says:—"Glass pipes, of large diameter, have not been successfully produced, but it has been predicted, by several large glass manufacturers, that it will not be long before some method of casting these pipes, successfully and cheaply, will be devised.

"Made in form similar to our present cast iron pipes, with some suitable device for a joint, and of a malleable glass, they would form a water pipe to which there could

scarcely be an objection; strong, tough, smooth and indestructible, and made of a material that is found almost everywhere. It is not without the range of probability that whenever a large quantity of pipe is to be used in any one locality, a furnace will be erected and the pipes made where they are to be used."

Some discussion upon the Water Pipe question followed, by Mr. W. J. Hoyt, Prof. L. M. Haupt, Mr. C. T. Thompson and the Secretary.

The Secretary presented, for Mr. Rudolph Hering, notes upon the Present Investigation of the Drainage and Water Supply of Chicago.

The city of Chicago obtains her water supply from Lake Michigan. The intake is two miles from shore and the water brought to the city by two tunnels, five and seven feet in diameter, driven through the clay which underlies the lake. The average daily consumption, as recorded for the last year, was 91,650,000 gallons, the supply per head being 137 gallons. The water of Lake Michigan is generally of excellent quality. Occasionally it is rendered undesirable as a drinking supply in the vicinity of the intake, from two causes. The action of the waves during stormy weather reaches down nearly sixty feet, and the clay at the bottom is, in consequence, disturbed, which, more or less, discolors the water supply to the city. The other and more important cause, is the danger of an occasional sewage pollution from the Chicago river. To devise the best means of guarding against these troubles, is the purpose of the investigation now being made.

The city is at present well supplied with good sewers. Nearly all the sewage is discharged into the main river and its branches which run through the city. The natural summer flow of these streams is practically nil. The sewage would gradually replace their water and tend to convert them into huge cesspools, the contents of which would be belched into the lake by the flood-waters carried by the river after every storm. By fortune topographical conditions, however, this state of things has not become serious, and the pollution of the lower river and the lake is now but rarely noticeable. About ten miles west of Chicago, is the divide betwen the Mississippi and the Great Lakes. It is only about ten feet above Lake Michigan and is crossed by the Illinois and Michigan canal, the lake-level being its summit-level. Thirty miles west it begins to descend, and finally reaches the Illinois river. Into this canal the sewage of Chicago is discharged to-day, and finds its way ultimately into the Mississippi river.

If the quantity of sewage were small, this disposal might be quite satisfactory. But Chicago is growing at a rapid rate; its water supply is large per head of population, and the quantity of sewage is therefore so great, that the discharge into the canal causes to-day a nuisance for many miles below. With its suburbs, Chicago has now a population of 800,000. The unbounded supply of good water at its side, and the comparative economy of distributing it, produces a very large consumption, and clearly indicates a large quantity of sewage to be provided for in the future.

The possible ways of disposing of it are three:

1. Intercepting sewers may collect and bring it to certain points from where it may be pumped through conduits several miles out into the lake, delivering as far from the intake of the water supply as practicable.

2. After collecting the sewage at some point south of the city it can be pumbed to some sandy areas about twenty miles distant and then purified by irrigation or filtration on land.

3. A large and deeper channel can be excavated, to replace the present Illinois and Michigan canal, which would carry enough water to sufficiently dilute the sewage of the future city and discharge it into the Illinois river.

The merits and demerits of these three schemes are now being studied.

In order to determine the feasibility of discharging the sewage into Lake Michigan, in a manner which would not pollute the water supply, a hydrographic study was made of the same, revealing a number of interesting facts in regard to the oscillations and currents of the lake. It is found that the wind is the prime factor in moving the water, and that the currents are generally in the direction of the wind.

The investigation of the scheme that contemplates a sewage disposal on land, develops some formidable figures. The future population is assumed at 2,500,000, and the water supply per day as 350,000,000 gallons, For broad irrigation the necessary area would reach over eighty square miles; and for intermittent filtration the area would be reduced to some twenty miles. The soil must be sandy and the nearest available territory is twenty miles south of Chicago.

The third scheme, by which the sewage would be turned into the Illinois river, means practically, to reestablish the ancient southern outlet of Lake Michigan and to pour its waters again into the Mississippi, where they went, geologically speaking, not long ago. The old bed of the outlet is quite marked. About eight miles of lime stone rock forms the barrier which prevented the water from wearing down the channel and discharging into into the Mississippi at this day.

About ten miles west of Chicago the Desplaines river descends from the north, having a water-shed of eight hundred square miles, discharging into this outlet at Summit, divides its water. A part flows eastward into the Chicago river and the lake, and a part flows westward, keeping the same name of the river above, until, when joining the Kankakee, it forms the Illinois river. The peculiarity of this topography which causes a river to split sending a part of its water into the Gulf of Mexico and the other into the Gulf of St. Lawrence, is matched by the peculiarity of the river bed itself, which, in summer, is practically dammed up by vegetation *west* of the summit, so that sometimes all the water goes into the Chicago river; and which, in winter, on account of ice dams *east* of the summit, discharges most of its water into the Illinois river. This, and a number of other points, bring many difficulties into the problem.

A channel which would so dilute the sewage that no offensive condition could occur, requires to be about 200 feet wide, and about 10 feet deep,—about the size of the Chicago river. It would have to be excavated for over twenty-five miles, eight of which are through rock. A double bifurcation of the Chicago river complicates the problem of constant circulation, which is a first condition if sewage is discharged into them. The flood-waters of the Desplaines river must be provided for, either by an enlargement of its channel, or by an interception and separate discharge into the lake north of the city, and numerous other difficulties arise in carrying out this scheme.

On the other hand, great benefits would appear, independent of the question of sewage disposal. A national advantage would be secured by the establishment of a large waterway between the Mississippi river and the lakes, to be used for commercial and military purposes.

The whole investigation will be completed within a year.

The Secretary announced the death, on November 6th, 1886, of William Brantley Cooper, Active Member of the Club, and read, from the *Washington County Advertiser*, of Fort Edward, N. Y., an interesting account of his life and work.

HOWARD MURPHY.
Secretary and Treasurer.

Genoa, Italy, Water-Works.

The directors of this company announce that they are prepared to receive applications at par for £150,000, being part of the total authorised issue of £300,000 Six per Cent. Debenture Stock of the company. The company was formed to acquire and carry out a concession granted by the Imperial Government of Italy to construct a new and improved system of waterworks for the city and suburbs of Genoa, which is at present inadequately supplied with water by the three old and almost obsolete sources of the Municipal, the Nicholai and the Corzente aqueducts. By the concession power is conferred for a term of 90 years, to take and store by means of reservoirs the waters from the rivers of Concasca or Marsiglia and Bisagno, and to lay iron water pipes alongside or under the main road from those rivers to the city of Genoa. About eight miles from the city, near to the source, a large reservoir will be constructed, covering an area of upwards of 20 acres, with a storage capacity of 150,000,000 to 200,000,000 gallons, or a reserve of over thirty days, supply. The population of Genoa has doubled since 1853, and now with its suburbs, numbers 250,000. The existing imperfect water supply serves only about 30 per cent. of the houses, and leaves a population of nearly 200,000 with no regular supply for domestic or other purposes. In addition, quantities of water are urgently needed for Government and municipal establishments, public institutions, barracks, mills, railways, shipping and other purposes. Contracts, within the capital of the company, have been entered into with firms of contractors for the completion of the waterworks and works within two years from Nov. 1, 1886, and the contractors will lodge in the names of the trustees for the debenture-holders interest at 6 per cent. per annum for the two years, viz, to Nov. 1, 1888, prior to the issue of the debenture stock.

Lead Pipe in Cement.

A report has been made of an examination made by a German chemist of some of the peculiarities acquired by leaden pipes which had been imbedded for a period of five years in a layer of Portland cement. It appears that a red coating was noticed, from one-twenty-fourth to one-eighth of an inch in thickness, the appearance of this corresponding with that of oxide of lead, as it is usually delivered in commerce. This coating was carefully removed, and the particles of lead coming with it were separated by means of a magnifying glass, and the specific gravity of this powder, carefully defined at fifty-nine degrees, F., and reduced for a vacum, varied between 8,002 and 9,670, This variation is explained by the presence of the metallic lead, mixed in the oxide of lead, and carbonate of lead. Qualitative analysis demonstrated that this powder contained oxide of lead, lead and carbonic acid, water, and traces of calcium: and the formation of such a peculiar coating on the lead pipe, though not heretofore noticed in other cases, is believed to be owing to the action of the oxygen in the air, in union chemically with that of the lime which was contained in the mortar.

CORRESPONDENCE.

Adjustment of the Wye Level.

NATIONAL WATER WORKS.
WYANDOTTE, KANSAS, Dec. 10, 1886.

ITOR ENGINEERING NEWS:

Having been much interested with the articles of rof. I. O. Baker, in the recent numbers of the "NEWS,' concerning surveying instruments, I wish to supplement that portion of them pertaining to the adjustment f the wye level, as also the article of Mr. Trautwine on the same subject (see pages 192-193 of his Engineers' Pocket Book) with a little of my own experience.

It appears that most engineers are satisfied to get he optical axis of the telescope into a level line, before hey adjust the level tube to it. That is to say, having adjusted the optical axis to a *level line*, they proceed at once to adjust the level tube to a parallelism with the optical axis of the telescope.

This is a mistake. We want the optical axis in the horizontal—and not in the level line. That is to say,—we want the optical axis of telescope in such position, that, when turned around on its vertical axis, it will lie in a plane that is tangent to the surface of the earth, at the place where the instrument stands. When the optical axis of the telescope is level, if we turn it around on its vertical axis, it describes the surface of a cone, whose apex is at the instrument, and whose angle is less than two right-angles, by the angle subtended by the terrestrial arc between the two level pegs, to which the instrument has been adjusted,—whence *the telescope points too low by half the angle subtended by the terrestrial arc between the pegs.*

Bearing in mind that one second of terrestrial arc is about 101½ feet, we see that, in the example given by Mr. Baker, (station pegs 400 feet apart) the telescope points about two seconds of arc *too low*, which is nearly $\frac{1}{16}$ of an inch in 400 feet, or ¼ of an inch in one mile.

Whence, before adjusting the level tube to the telescope, the latter must be elevated through the angle between the chord and tangent of the terrestrial arc,—in this example, $\frac{1}{16}$ of an inch, in the 400 feet.

This correction varies as the square of the distance between the level pegs and for convenience in making it, it will be well to take the distance between the pegs some even multiple of the length of 1 second of terrestrial arc, as 404, or 606 feet.

And instead of the tentative method of finding the equal readings of the rod on the two pegs, as given by Mr. Trautwine (see his Engineers'Pocket-Book,—pages 192-193); it will be better to find it by direct calculation, as explained by Mr. Baker, (see ENGINEERING NEWS for December 4, 1886—page 357). And instead of setting the instrument up near to one of the pegs, to find the difference of the rod-readings on them, as suggested by Mr. Baker, it will be better to set the instrument up in line of the two pegs, making the distance from instrument to furthermost peg, greater than the distance between the two pegs, by some aliquot part of the latter, for, with the instrument near to one of the pegs, but not in line, the difference of the rod-readings on the two, is vitiated by the error of instrument due to the distance between the instrument and the near peg.

An example will illustrate to new beginners.

To adjust the level tube, and the optical axis of the telescope to the horizontal.

Set up two pegs, say six seconds of terrestrial arc, or 606 apart. Then, setting up the instrument in line o the two pegs, and at a point precisely midway between them, drive the two pegs, till the rod-reading on both of them is the same,—then the heads of the pegs will be in the same level, whether the instrument is in adjustment or not.

This done, move the instrument to a point beyond one of the pegs, in line of the two, and at a distance that is an aliquot, or approximately an aliquot, part of the distance between the two,—or in this case, say 40 feet, which is roughly the $\frac{1}{15}$ part of 606 feet.

From this point, observe the readings of the rod on the two pegs. If they are equal, then the optical axis of the telescope is parellel with the chord of the terrestrial arc 6 seconds in extent, and is said to be level.

But if these readings should be different, as they most likely will be, divide the difference d, by the ratio of the distance between the pegs to the distance from instrument to nearest peg—in this case 15—thus $\pm d \div 15$, is the correction for the rod on the near peg; while $\pm 16\,d \div 15$ is the correction for the reading of the rod on the furthermost peg, the + sign to be used when the reading of the furthermost rod is the smaller, and the contrary.

Then the line of sight being adjusted to the new reading, by means of the foot-screws of the level, the optical axis of the telescope is strictly parallel with the chord of the terrestrial arc, and, as before, is said to be level.

But this is not what we want. The telescope points *too low* by the angle between the tangent and the chord of the 606 feet arc, or the half of 6 seconds, while we want it in the horizontal.

Multiplying the arc of 3 seconds = .000015 (see tables of circular measure) by the distance from instrument to furthermost peg = 646 feet, and by 12, we have .1124 or practically one-eighth of an inch for a further correction by which the reading of the furthermost rod must be increased.

The telescope being elevated to the new reading of the rod on the furthermost peg, by the foot-screws, the level-tube may be adjusted to read zero, by means of the screw between the tube and the telescope, when the instrument will be adjusted to the horizontal, as required. This error for 3 seconds, is nearly 1 inch per mile.

Those instruments adjusted by the manufacturers from points within the limits of a work shop, do not require the above correction for angle between the chord and tangent.

H. C. PEARSONS.

Literary Note from The Century Co.

The sales of *The Century Magazine* have gone up over 30,000 copies in six weeks, since beginning the Life of Lincoln. A second edition of December will be issued on the 15th. A veteran New York publisher predicts that the permanent edition of the magazine will go beyond 300,000 before the completion of the Lincoln history. The January installment, which is said by the editors to be of most surpassing interest, occupies thirty pages of the magazine, and treats of Mr. Lincoln's settlement in Springfield; his practice of law in that city; the Harrison campaign; Lincoln's marriage; his friendship with the Speeds of Kentucky; the Shields duel; and the campaign of 1844. The illustrations are numerous, including portraits of Joshua Speed and wife, of Mrs. Lucy G. Speed, Milton Hay, President Harrison, General Shields, William H. Herndon (the law partner of Mr. Lincoln), and Mr. Lincoln himself, from the photograph presented by him to Mrs. Lucy G. Speed, in 1861. Pictures are given of the house where Lincoln was married, also the house where he lived after his marriage, etc., etc.

Canadian Society of Civil Engineers.

We are much pleased to announce that the unremitting efforts of the promoters of a Society of Civil Engineers for the Dominion have been crowned with success. We learn that all details were adjusted at a meeting in Montreal on the 9th, and the constitution will be sent out to the members of the profession with a request that each one who gets a copy will join. Ballot papers for the officers will be sent out, after the model of the American Society of Civil Engineers early in January. A provisional committee has been formed with Mr. T. C. Keefer, C. M., Chiraman; H. F. Perley, W. P. Anderson, R. Surtees, J. Kennedy, P. A. Peterson, P. W. St. George, Prof. Bovey, Col. Gzowski, A. D. C. to the Queen, Kivas Tully, W. T. Jennings, Alan Macdougall, Secretar y

AN official report of the Dutch State railways refers, among other things, to the effect produced by various paints on iron plates, and showing that the red lead paints resist atmospheric influences much better than those of brown red and iron oxides. The red lead paint adheres closer to the metal, and possesses greater elasticity than the others. It was also found that better results are attained if, before the paints are applied the plates are pickled, instead of being merely scraped and brushed. The test plates in this case were pickled in muriatic acid, washed with water, thoroughly dried, and while warm carefully oiled. Again, iron and steel being peculiarly liable to corrosion in salt water, vessels made of them require special protection and this can be given by covering the metal with some alkaline or basic substance, or the oxide of some metal electro-positive to it. For this purpose caustic lime and soda are very efficient, and act equally well when made into a paint with oil; but their efficiency is destroyed when they cease to be caustic, or when saturated with carbonic acid. Magnesia is equally efficient and does not absorb carbonic acid. It therefore makes as good a material for a paint as could be desired, and moreover, forms an excellent basis on which to lay an anti-fouling paint, which it protects from the galvanic action of the iron by isolating it, while it does not affect the anti-fouling qualities.

SELECTED MISCELLANY.

ACCORDING to a French contemporary, a good transparent cement may be made from the following recipe:—Mix in a well stoppered bottle 10 drachms of chloroform with 12½ drachms of non-vulcanized caoutchouc in small pieces. The solution is easily effected; when finished add 2½ drachms of mastic, and let the whole macerate from eight to ten days, but without heat. A perfectly white and very adhesive cement is thus produced.

IRON FOR STREET PAVING.—A new form of iron pavement has been laid on Madison street, just east of Dearborn, which is attracting a great deal of interest, not only from the average passer-by, but from practical men and those interested in the construction of a good and substantial roadway. The material used is of iron rolled into the shape of small T-rails, 1½ inches high, laid with the flat side, or what is known as the bottom of the rail, up. This surface is an inch and a half wide and has indentations across it at intervals of 6 inches, for the purpose of insuring a more perfect foothold. The rails are fastened together by being securely bolted with wrought-iron bars, and are laid an inch and a half apart. They rest on 2-inch planking, and are secured thereto by staples, which pass over the bolts. The pavements is laid in sections 12 feet in length by 2 feet in width, with stone blocking along the kerb and next to the railroad track. The space between the rails is filled up to the street level with tar and gravel, thus making it perfectly waterproof. The merits of this pavement are said to be that it will keep in a smooth condition for a period probably longer than any stone or wood blocking, and is wonderfully less noisy than the stone. Charles Peck is the inventor, and the Chicago Iron Paving Company is engaged on the work.—*Industrial World*, Chicago.

PLAN FOR MAKING BRUSSELS A SEAPORT.—The Municipal Authorities of Brussels are at present negotiating with an English syndicate for making that city a seaport. It is proposed to connect the capital with the sea by means of a canal 20.3 feet in depth, and wide enough to enable vessels of 2,000 or 3,000 tons burthen to reach the town. Another canal is to connect the capital with the Scheldt, and thus with the port of Antwerp. The port to be constructed at Brussels will be situated on the plain of Montplaisir, in the suburb of Scherbeck, and will hold twenty ships of 2,000 or 3,000 tons. There will also be constructed docks and warehouses, which will be connected by rail with the great coal mines at Charleroi. For the reception of cereals a warehouse, 200 feet long, 100 feet wide, and 100 feet high, will be built, provided with all modern appliances, whilst tanks, pumps, etc., for holding and discharging petroleum will also be erected. The cost of the whole scheme is estimated at $25,000,000 for which the city of Brussels will pay an annual sum from the day of the completion of the canal, beginning with $3,500,000 the first year and continued as the receipts increase until the canal has become the property of the town. In the meantime the city will receive a share of the receipts. The King of the Belgians is much interested in this project, as he hopes to divert by it all the continental trade of the Congo Free State to Belgium.

ILLUMINATING GAS STATISTICS.—At the recent meeting of the American Gas Engineers' Association at Philadelphia, Mr. W. W. Goodwin, of that city, read a paper on "Gas Statistics." A summary of some of its exhibits is contained in the following: There are 971 companies in the United States, 888 of which responded to the queries of the compiler, and 47 in Canada, 7 of which did not reply; 592 companies in the United States manufacture their gas from coal, and 296 under various patents and processes known as water-gas, water and oil-gas, etc. In Canada 24 companies manufacture from coal and 16 from other processes. One company manufacturing gas from coal with an output of 11,000,000 cubic feet, received 75c. per 1,000 feet, 26 companies, with an output of 1,879,900,000 cubic feet of coal manufactured gas, received $1.50; 6 companies manufacturing by other processes, with an output of 900,000,000 cubic feet, received $1.50, and 45 companies, manufacturing from coal, with an output of 468,000,000 cubic feet, received $2.25 per 1,000 feet. The output of 495 coal-gas companies was 17,502,305,000 cubic feet, the income from which was $30,452,710; 188 companies manufacturing by other processes have an income of $10,291,000 from an output of 5,554,000,000 cubic feet. The average price of coal gas is $1.73 $\frac{25}{100}$ of gas manufactured by other processes, $1.81 $\frac{1}{10}$. In the matter of public lamps 1,056 were receiving gas at a cost of 1c. per hour, 100 at 1¼c., 142 at $\frac{7}{8}$c., and 100 at 1¾c.; 6,000 lamps ranged from 1c. to 4.7c. per hour; 104,000 lamps realized $3,317,287, an average of $30.17 per lamp. The output of gas by 517 companies manufacturing from coal required 1,908,611 tons of coal. The output of 206 companies using water and other processes required 178,563 tons of anthracite coal. The capital required to run all the gas interests amounts to $261,000,000, the income from which is about $60,000,000.—*Bradstreet's.*

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THE Third Avenue (Surface) R. R. Co., of New York, decided at its meeting of December, 13, to adopt the cable system on its line. They are impelled to do this in order to compete with the elevated roads. Construction is to commence in the spring and the cost is estimated at $1,500,000.

MR. E. L. CORTHELL, chief engineer of the Tehuantepec Ship Railway, will address the Academy of Sciences at Columbia College in this city on Monday evening, December, 20. His subject will be "The Isthmian Ship Railway" which he will illustrate by maps and lantern views. A cordial invitation is extended to all interested in this important topic, ladies as well as gentlemen.

WE have received a number of communications from subscribers who have been testing the various processes for copying tracings as given in the paper of Mr. Thwaite in our issue of November 27.

Judging from the nature of the correspondence there seems to be some trouble attended with the successful manipulation of formula No. 7, the Shawcross direct process. We can only say that the formulæ as published by us agree with the original paper read before the Institution of Civil Engineers. The trouble probably arises from a lack of experience and we would like to hear from some expert in that and the other processes described. One correspondent reports that his druggist denies the existence of such a chemical as "hydrogen tartrate" in the Shawcross formula; another finds some difficulty in applying to the paper the pasty compound resulting from the proportions given. Light upon these points would evidently be welcome to an interested class.

FOR the benefit of subscribers who have already ordered the book through us, and to those proposing to do so, we would say that the publishers of "The Economic Theory of the Location of Railways," by Mr. A. M. Wellington, announce that the revised and enlarged edition is now in the printer's hands and will be issued early in the coming year.

We have already expressed our opinions very fully upon the excellence of this work and can only add that the present edition will present extensive revision of previously published matter and much additional material collected by its author since 1877. If valuable before, as the engineering profession seemed to think, judging from the demand, the present edition must be much more so.

In regard to the price, which we have been before unable to state in answer to queries, the announcement is made that this will be $5.00 post-paid, or $4.00 for five or more copies to one address plus expressage.

A Great Drainage Project in the North West.

The Minnesota hard wheat from the Valley of the Red river of the North is as famous among northern millers as the Sea Island cotton among the spinners of the east. The portion of the valley in Minnesota, producing this superior hard wheat averages about twenty miles wide and borders for about 200 miles along the east side of the Red river.

The great agricultural value which these lands will have if properly drained has led to a close study of the question of their drainage.

A drainage convention was held at Crookston on the first of July last, and the matter of drainage earnestly discussed. A drainage commission was appointed by the convention, consisting of some of the most active and influential men of the valley with instruction to procure the necessary surveys and plans. The commission retained Mr. J. T. Fanning, C. E., of Minneapolis, as their consulting engineer and Mr. C. G. Elliott was soon placed in the field in charge of the surveys. The commission has just reported to an adjourned meeting that surveys have been completed in five counties over a total area of about 3,000 square miles, and the plans for the drainage of this area, with the detailed reports of the engineers were laid before the convention.

It appeared by the reports that the lands bordering along the river have generally slopes of about two feet to the mile, and the slope increases with distance from the river to 6 or 8 feet to the mile at twenty miles from the river. The whole area of prairie is nearly a true plane with frequent slight undulations and occasional sloughs and coulies. Accurate leveling at every section corner, and often levels at angles of each quarter section were found necessary to properly locate the drainage ditches. The entire three thousand square miles were thus surveyed and leveled by the several field parties and all points referred to the datum of the sea level. The main and subordinate watersheds were indicated and the intercepting, main and subordinate ditches laid down on the county maps prepared for the purpose.

It is surface drainage that is chiefly required, to remove the waters of the melting snow as rapidly as possible in the spring and thus admit early seeding. The complete information presented by the commission and their recommendations were enthusiastically received by the convention.

This survey and plan of drainage is by far the most extended and comprehensive yet undertaken on this continent with such careful detail. This drainage successfully accomplished will lead to its further extension over equally large areas in Dakota and in the portion of Manitoba bordering on the Red river.

Statistics show that the wheat production of this valley has already assumed gigantic proportions and its superiority always ensures it a ready market. When the drainage already planned is perfected, several million additional acres will become unsurpassed for wheat, grass or root culture and excellent for stock raising.

The drainage convention has appointed committees to secure the passage of an adequate drainage law at the coming session of the State Legislature and to further the project in several ways.

Bordering this valley on either side are belts of timber and mineral lands, and the upper Mississippi river affords ample water power for manufacturing enterprises so that apparently this section of the Northwest is destined to gather a vast population and become the center of vast industries.

The Value of Feed-Water Heaters.

It always pays to make use of feed-water heaters to supply the water to the boilers at a high temperature. In the first place this is conducive to the durabiliy and life-time of the boiler. It takes away all chance of an extremely cold mass of water chilling the hot plates. Again by ensuring a more equal temperature of the whole mass of water within the boiler, it acts, in a measure, as a preventative of "priming" or of the generation of wet steam.

But its main advantage is the direct fuel saving which it ensures. For where feed-water heaters are used, the heat for warming the water is derived from the exhaust steam of engines and heating plants, which would otherwise go off into the atmosphere as so much waste.

To fully appreciate the saving effected by the use of proper feed-water heaters of adequate proportion, which utilizing exhaust steam otherwise going to waste, raise the temperature of the feed-water from the atmospheric temperature to about 200° Fahr. the process of generation of steam in the boiler, and its heat requirements, must be kept in mind.

All that portion of the heat energy developed in the furnace by the combustion of the carbon and other calorific ingredients of the fuel, not lost by waste of chimney gases and by radiation, is imparted to the water in the boiler. The first thing this heat does is to raise the temperature of the water from the temperature of feed, at which it is supplied to the boiler, unto the temperature corresponding to the pressure under which the steam is being generated. Then it supplies the heat

(known as latent heat) required to change the molecular constitution of the water so as to transform it into steam. This so-called "latent" heat performs internal work, and is actually represented in the steam by its molecular activity, viz.: by the expansive and other peculiar properties destinguishing steam.

Let us assume that the steam is generated in the boiler at sixty pounds gauge pressure, corresponding to an absolute pressure of seventy-five pounds per square inch, and let us assume that the atmospheric, or normal temperature of the water (in a winter's day) approaches 32° Fahrenheit. Then from Regnault's tables, we learn that to cause one pound of water in boiler, supplied at 32° Fahr., to be generated into steam at 60 pounds gauge pressure, there will be required, and must be supplied,1175.8 heat units, 897.6 representing the latent heat of steam at that pressure, and 278.2 the heat units required to raise the temperature of water from 32° Fahr. to 307.4° Fahr. the temperature of the steam at seventy-five pounds absolute pressure.

If, however, the temperature of the feed-water is 200° Fahr. instead of 32° Fahr., we learn from Regnault's tables that there will be required only 109.6 heat units to raise one pound of water from the temperature of feed to that of steam, namely, to 307.4° Fahr. Adding 897.6 "latent" heat units, the total heat units required for pound of water evaporated into steam will be 897.6 + 109.6 — 1007.2, instead of the 1175.8 heat units required when the feed water temperature is 32° Fahr.

Since all the heat units which must be supplied to water in boiler to generate it into steam must be derived from the fuel on the grate, the saving effected by supplying the feed water at a temperature of 200° Fahr., instead of at 32° Fahr., when the additional heat from raising feed-water temperature is derived from the exhaust steam, otherwise waste, will be measured by

$$\frac{(1175.8-100\ 7.2)\times 100}{1175.8} \text{ equal } 14.3\ \%.$$

In the same way has been calculated the following table, showing percentages of saving of fuel by heating feed water to various temperatures by exhaust steam, otherwise waste.

Percentage of Saving. (Steam in Boiler at 60 Pounds Gauge Pressure.

Final Temperature. Fah. Degrees.	Initial Temperature of Water (in Fahrenheit Degrees.)												
	32°	40°	50°	60°	70°	80°	90°	100°	120°	140°	160°	180°	200°
60	2·39	1·71	0·86	——	——	——	——	——	——	——	——	——	——
80	4·09	3·43	2·59	1·74	0·88	——	——	——	——	——	——	——	——
100	5·79	5·14	4·32	3·49	2·64	1·77	·90	——	——	——	——	——	——
120	7·50	6·85	6·05	5·23	4·40	3·55	2·68	1·80	——	——	——	——	——
140	9·20	8·57	7·77	6·97	6·15	5·32	4·47	3·61	1·84	——	——	——	——
160	10·90	10·28	9·50	8·72	7·91	7·09	6·26	5·42	3·67	1·87	——	——	——
180	12·60	12·00	11·23	10·46	9·68	8·87	8·06	7·23	5·52	3·75	1·91	——	——
200	14·30	13·71	13·00	12·20	11·43	10·65	9·85	9·03	7·36	5·62	3·82	1·95	——
220	16·00	15·42	14·70	14·00	13·19	12·33	11·64	10·84	9·20	7·50	5·73	3·93	1·98

A good feed-water heater of adequate proportions should readily raise the temperature of feed-water up to 200° Fahr., and, as is seen by inspection of the figures in above table, thus effect a saving of fuel, ranging from 14.3 % to 9.03%, according as the atmospheric or normal temperature of the water varies from 32° Fahr. in the height of winter, to 100° Fahr. in the height of summer.

It will readily be appreciated that the first cost of heater, which enters in the current expense account only as the sum of interest and depreciation on first cost, is a small matter compared to the money value of the fuel saving effected.

The Lake Marine and the Iron Ore Trade.

The past season has been a very prosperous one for our lake marine, greatly in consequence of the increased shipments of ore, which have increased from 2,938,486 in 1885, to 3,536,500 gross tons this year, and it is expected they will reach 4,000,000 tons in 1887—if vessels can be found to transport this amount, in addition to the other commerce of the lakes.

The registered and enrolled tonnages on the lakes, including everything of above twenty tons register, was, June 30, 1885 689,406 tons for 2,684 vessels, of which 1,162 vessels registering 334,620 were steamers. Besides those launched in the interval twenty, eight new vessels having an aggregate capacity of 48,000 tons are now building. The Duluth *News* thinks these, with a fair season will be able to carry 490,000 tons of freight, about the expected increase in Lake Superior ores. But Duluth expects to ship 5,000,000 bushels more grain than last year, and figures upon ore and grain freights from Lake Superior to the amount of $3,000,000.

Marine architecture is receiving a great deal of attention on the lakes, where they are building a very superior class of steel steamers. The best and largest of these is the *Susquehanna*, of 2,800 tons, designed by George B. Mallory, M. Am. Soc. C. E., of this city, built by Captain M. M. Drake, at Buffalo, and engined with triple expansion engines, by M. C. Trout of the King Iron Works of the same city.

This is believed to be the first triple expansion engine put in an American steamer, the engines in the *Cherokee* and *Seminole* having been put in by Cramp a little later. Mr. Mallory now has another steel steamer of 3,000 tons on the ways, to be launched as soon as possible, these two being the largest vessels on the lakes.

The Brooklyn Bridge.

At the meeting of the Bridge Trustees on December 13, the Committee on Grips and Brakes reported that they had examined 113 plans; Superintendent Martin approved of the Eames Vacuum Brake and a contract was then ratified with this company to the amount of $4,060, to fit up the present cars.

President Thurber moved that on and after February 1, 1887, no tolls be collected on the footway, he believing that under the laws of 1878 the trustees possessed the right to make one part of the bridge free as long as toll was charged on another part. After some debate Trustee Clark suggested that the carriageway be included and the president was then directed to appoint a committee of three to draft a petition and an act to be submitted to the Legislature to make both promenade and carriageway free, if in the judgment of the Board such action should be deemed advisable.

The receipts for November were $69,771, and the expenditures $83,600. The number of passengers was 2,529,206. The receipts from tolls for the year were $743,539, of which $17,853 came from the promenade and $64,324.01 from the carriageways. The number of passengers was 27,047,984, an increase of 6,422,658 over the previous year. The expenditures exceeded the receipts by $270,023. This was accounted for by the completion of fourteen warehouses, the buying of new cars, the new extension, and the putting in of new machinery.

The Brussels Ship Canal.

The recent and persistent agitation for the deepening and enlargement of the existing Brussels, or Willebroeck, canal calls for some short description of present conditions. The following is an abstract from an article in the *Manchester Guardian*:—

The Willebroeck canal was originally constructed in the middle of the sixteenth century to put Brussels into communication with Holland, France and England. The canal runs from Brussels to the Rupel, about eighteen miles, where it joins the Scheldt above Antwerp. The canal was from 26 to 33 feet wide on the bottom, 98½ feet at the water surface and from 6½ to 7 feet deep. In 1824 agitation was commenced for a deeper canal, and a Dutch engineer proposed a channel 19½ feet deep carried direct to the Scheldt. Nothing was done however on this plan, and in 1836 the city of Brussels deepened the canal to 10 feet at its own expense. In 1874, Brussels, Malines and Louvain united in commissioning M. Calson to make an exhaustive study of a maritime canal with branches to the two last named cities. In 1876 M. Calson reported a scheme for deepening the existing canal to 22 feet with an opening directly into the Scheldt, but nothing was done. In 1882 a Royal Commission was appointed to inquire into the subject and in 1884 condemned the proposal for deepening the present canal.

At present, the distance from Antwerp to Brussels is about 32 miles by the Scheldt and the existing 10 feet canal. There are five locks to be passed and it is accessible to vessels of 100 to 250 tons. The aggregate annual seagoing tonnage is about 22,000 with a decreasing tendency, mainly the regular service of three or four London-bound vessels. The aggregate interior tonnage of barges and small river and canal steamers ascending to Brussels is about 800,000 per annum.

By the proposed enlarged canal the distance to Antwerp would be reduced to thirty miles, but there would still be five locks including tidal locks at Scheldt entrance; it would be accessible to ships of 3,000 tons and the cost to Brussels is estimated at about $4,000,000. Including the extensions to Malines and Louvain, the total expense would be about $6,300,000. At present the Belgian government proposes to do all the work; but a London syndicate has proffered to deepen the existing canal to 21 feet, build new docks and quays capable of taking twenty ships of 2,500 tons each, provide ware-houses, sheds, grain-elevators, etc., under a government or municipal subvention of $360,000 per annum as one of the chief conditions of the contract.

Viaduct.—The city of Chicago contemplates the erection of a viaduct over the railroad track at Western avenue and Kinzie street, early next year, for which City Engineer S. G. Artingstall has furnished an estimate of cost to the Department of Public Works. The cost of approaches is figured at $114,600, arch spans for same $13,500, and improvements on line of approach $65,000; a total of $193,100. Of this amount the railroad companies will be required to pay two-thirds. The structure will be of iron with stone supports.

One Year's Progress on the New Croton Aqueduct.

(See Map on Page 409.)

The following table tells its own story of the aggregate results accomplished in one year by the contracting firms now at work on the New Croton Aqueduct. The average advance per week in each heading has been about 32 feet. We would remind our readers that the individual heading progress shown is only for the dates given; the total "north and south progress" furnishes the essential figures for comparison. As will be seen, two-thirds of the total aqueduct tunnel was driven on December 1, 1886. The figures given are taken from the official returns in the office of the Aqueduct Commission.

ONE YEAR'S PROGRESS ON THE NEW CROTON AQUEDUCT TUNNEL.

Section.	Portal or Heading.	Progress Report for Week Ending November 28, 1885. Feet.				Progress Report for Week Ending November 27, 1886. Feet.				Total Progress in Both Headings.		Advance in Year.	Remaining Aqueduct.
		Prog. North.	Total Prog. North.	Prog. South.	Total Prog. South.	Prog. North.	Total Prog. North.	Prog. South.	Total Prog. South.	Nov. 28, '85.	Nov. 27, '86.		Nov. 27, '86.
2	0	.....	.....	61	1381.3	.....	.....	0	3014.9				
"	1	0.4	105	1.5	101	0	1532.5	36	1535.5				
"	2	.....	.....	.....	.....	12	914	0	1117				
"	3	1.4	32.8	13.6	50.2	42	1627.4	28	1684.6				
3	4	51	456.3	36	451.7	25	2364.3	26	2250.7				
"	5	15	785	31	574	22	2215.9	25	2245.1				
"	6	0	127	0	138	47	2330.3	37	2014.7				
4	7	56	464	39	427	37	2588	0	1806				
"	9	0	829	51	1292	0	1727	28	3136				
"	10	50.5	807.5	46	790	24	2578	10	2424				
5	11 A.	51	1656	0	24	29	3575	0	24				
"	11 B.	0	43.6	49	1387	0	43.6	24	3332				
Brown, Howard & Co.		225.3	5256.2	328.2	6516.2	238	21496	214	24584.5	11,772.4	46,080.5	34,308.1	20,756
6	12 A.	53	718	0	204	25	2291	0	295				
"	12 C.	.....	.....	.....	.....	0	4	0	59				
"	Portals.	0	19	0	112	0	63	0	156				
"	12 B.	.....	.....	.....	.....	0	6.8	0	1858				
7	13	0	299.6	0	813.4	0	1933.6	0	451.4				
"	14	33	800.9	0	55.8	0	1581.9	0	55.8				
"	14 A.	.....	.....	10	880	.....	.....	45	2283				
"	15	20	303.2	12	3298	61	1935.2	38	2189.8				
8	16	28	769.1	14	841.9	45	2325.1	43	3044.9				
"	17	36	955	58	882	40	2626	20	2503				
9	18	37	1119	0	450	53	2984	0	665				
"	18½	11	82	15	97	0	619	45	1722				
"	19	0	429	0	578	37	1862	27	2222				16,683
O'Brien and Clark..		218	5494.8	115	5396.9	261	18233.6	218	17514.9	10,891.7	36,631.5	25,739.8	16,683
10 B.	19½	.....	.....	.....	.....	0	376	31	392				
"	20	30	1000	36	674	0	2155	22	2447				
"	21	29	731	25	669	76	2779	45	2301				
11 A.	22	29	871	47	779	40	3048	0	1872				
"	23	45	732	51	737	0	2068	0	3198				
"	24	20	253	0	75	0	1082	0	75.0				
Heman Clark		162	3587	159	2934	116	11508	98	10285	6,921	21.793	15,372	2.339
12	25	.....	.....	.....	.....	49	190	0	22				
"	26	.....	.....	.....	.....	0	496	0	175				
O'Brien & Clark.....		.....	.....	.....	.....	49	686	0	197	Included in above.			1,017
13	27	.....	.....	.....	.....	29	137	30	122				
"	28	.....	.....	.....	.....	0	86	0	91				
14	29	.....	.....	.....	.....	19	129	38	145				
"	30	.....	.....	.....	.....	13	415	16	424				
"	31	.....	.....	.....	.....	22	493	15	451				
"	32	.....	.....	.....	.....	6	548	.....	.....				
John Brunton & Co.		.....	.....	.....	.....	89	1808	94	1233	.....	3.041	3.041	8,859
									Total Aqueduct, Feet....	29,185.1	107,546	78,360.9	49,684
									" " Miles..	5.53	20.37	14.84	9.41

OBITUARY.

Martin Coryell.

Martin Coryell, whose death at Lambertville, N. J. was noted in a late issue, was born on July 20, 1815, at New Hope, Bucks county, Pennsylvania. He was the son of Lewis S. Coryell and the grandson of Immanuel Coryell one of the early settlers in that section. Coryell's Ferry on the Delaware river derives its name from this family.

Martin Coryell was educated in the schools of his native town, and at the select school of Dr. P. O. Studdiford, of Lambertville, and was for several years a pupil of the then eminent mathematician and astronomer John Gummere, of Burlington, N. J. Failing health caused him to abandon his studies, and for a time he was apprenticed to a carpenter, until accident brought him into contact with Canvass White, who was engineer of the Delaware and Raritan canal. Mr. White was so pleased with the first humble services of young Coryell that he employed him in establishing and determining high and low water mark on the Delaware river, and then gave him a position as a rodman on the canal.

In 1839-40 he was retained in the State service as a principal assistant on the Delaware Division canal, and there remained until 1842, when he took charge of the Morris canal as engineer under John Cryder, representing the English bondholders. This proved a very troublesome, and pecuniarily, a disastrous affair, and in the immediately following financial crisis work was stopped.

Mr. Coryell then turned his attention to law and was enrolled as a fellow-student with Hon. J. Donald Cameron in the law-office of B. H. Brewster, of Philadelphia. But on account of injury to his eyes from night-reading he soon sought another field. In 1844, Mr. Coryell was employed by the Canal Commissioners of Pennsylvania, on the Columbia railroad; his chief duty being to inaugurate and make popular the change from horse-power to steam, as a motive power, on the West Chester railroad. He accomplished this, and was then made superintendent of the Schuylkill level of the Columbia R. R., extending from Philadelphia to the old Inclined Plane at Belmont.

During the next few years he officiated as engineer in various parts of the country, with the Hazelton Coal Company, as engineer and manager of the Lake Superior Copper Company, etc. In 1847, he returned to New Jersey and built a coal-wharf at Bergen Point, and then entered the employ of the Raritan Canal Company under Ashbel Welsh. While thus engaged, Mr. Coryell located the greater part of the Belvidere railroad, and built it from Trenton to Lambertville. In 1853, he was Chief Engineer of the Brunswick canal, and during the next six or seven years was engaged in like positions on railroads and canals in Pennsylvania and New Jersey. In 1862, he settled at Wilkesbarre, Pa., as a civil and mining engineer, and in 1864, was made the Secretary, Manager and Treasurer of the Warrior Run Mining Company.

In 1876, Mr. Coryell finally settled at Lambertville, N. J., where he successfully established the city water-works in which he owned a controlling interest. At the time of his death Mr. Coryell was engineer and superintendent of the water-works and a director of the Amwell National Bank. Mr. Coryell was elected a Member of the American Society of Civil Engineers on December 4, 1867, and, was a member of the American Institute of Mining Engineers.

PERSONAL.

S. M. HIGHLANDS, C. E., is Superintendent for the Meridian Water-Works Co., Meridian, Miss.

B. S. GRANT, civil engineer on the Southern division of the Mobile & Ohio R. R., was married December 8, at Enterprise, Miss.

STEVENSON TOWLE, expert in sewer engineering, will examine and report upon the sewerage system of Central Park, New York City.

CHARLES H. BETTS, C. E., Cincinnati, O., has been assigned to duty on the West Alabama R. R., under CHARLES B. PERCY, Assistant Engineer.

Captain JAMES F. GREGORY, Corps of Engineers, to be Major, vice GILLESPIE, promoted. 1st Lieutenant Willard Young, Corps of Engineers, to be Captain, vice GREGORY, promoted.

MAJOR KILLEBREW, of Jackson, Tenn., has gone to Eagle Pass, Tex., to locate a line which is to connect with the Mexican National R. R.

W. S. PAGE has been appointed Assistant General Superintendent of the Chicago & Indiana Coal R. R., with headquarters at Brazil, Ind.

CAPT. H. M. ADAMS and SECOND-LIEUTS. W. M. BLACK and H. M. CHITTENDEN, U. S. Engineers, will be examined for promotion at New York on January 10, 1887.

Additional 2d Lieutenant CHARLES S. RICHE, Corps of Engineers, to be 2d Lieutenant, vice Sanford, promoted.

COL. JAMES BOONE died at Lancaster, Pa., December 13, at the age of 81 years. He was a pioneer in railroad and telegraph building, Assistant Superintendent of the old State Railroad and Superintendent of the Portage roads.

THE corps of engineers in charge of the lock enlargements on the Oswego canal consists of CHARLES G. WHITBECK, Chief Engineer; G. D. BALTIMORE, First Assistant Engineer; CHARLES H. BARBER; JAMES RYAN Jr., all located at Phœnix, N. Y.; FRANK LEMOREE, at Mud Lock; and CHARLES B. BREED, Hinmanville.

GEORGE S. GREENE, J. J. R. CROES and JAMES B. FRANCIS have been appointed by the Aqueduct Commissioners as members of a Commission to report on the practicability, feasibility and constructive detail of the Quaker Bridge Dam.

ROBERT VAN BUREN, Chief Engineer of the Department of Public Works, of Brooklyn, has been offered, and has declined, the position of President of the City Railroad Co. His present salary is $4,500 and the railroad company offered $10,000 per annum.

C. W. IRISH, Civil Engineer, of Iowa City, Ia., for some years past engaged mostly in railroad engineering on the Chicago and Northwestern, has been appointed Surveyor General of Nevada—a good appointment, as MR. IRISH is a very competent man.

J. B. ASHLEY, Chairman of the Committee on Blanks and Instruments of the Ohio Society of Surveyors and Civil Engineers, asks makers of instruments to send in an exhibit for the coming convention of the Society at Columbus, Ohio, January 11th to 15th, 1887. For railway rates address W. H. Jennings, Columbus, Ohio.

ROSSITER W. RAYMOND has been appointed by the Aqueduct Commissioner as an expert to examine into the lighting and ventilation of the aqueduct tunnel, in place of JAMES T. GARDINER.

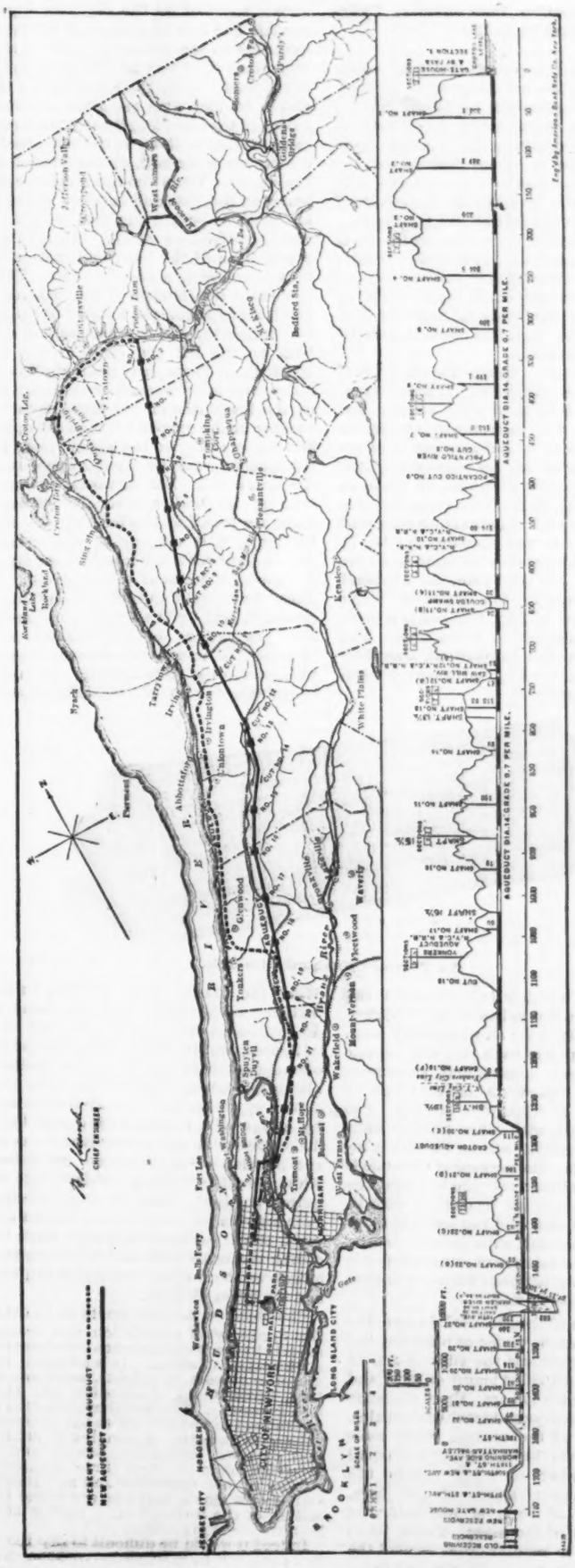
MR. JOHN B. ROOT died at Port Chester, N Y., on December 11, aged 56 years. MR. ROOT's name has been honorably connected with a number of important inventions in the field of mechanical engineering, notably spiral pipe and sectional boilers. Of this latter device MR. ROOT was one of the first advocates, and all boilers of this type practically contain many of his original ideas. MR. ROOT was a Member of the American Society of Mechanical Engineers.

JOHN CHIPMAN HOADLEY, whose death on October 21st, has already been noted, was born in New York State in 1818. His first engineering experience was in connection with the Erie canal; leaving the State service in 1844, he became engineer in charge of the erection and equipment of mills at Clinton, Mass. He thenceforh devoted himself to mechanical engineering, being for a number of years manager of an extensive machine-shop in Lowell, manufacturing locomotives and textile machinery. He there invented the Hoadley portable engine, a type of probably the first application of scientific principles to the construction of high-speed engines. During his later life he abandoned commercial and manufacturing affairs and obtained a wide and honorable practice as a consulting engineer and expert in patent cases. He was a frequent contributor to technical literature and his influence was felt in engineering practice in mill work, steam application, sanitary engineering and in the methods of expert evidence, in which last his wide reading and experience, and retentive memory made him pre-eminent.

BENJAMIN HYDE EDGERTON, one of the oldest civil engineers in the northwest, died at Chicago, on December 9, aged 75 years. MR. EDGERTON was born near Norwich, Conn., in April, 1811; with his parents he removed to Taberg, near Rome, N. Y., at an early age. After some experience with a merchant in Rome, he was employed in 1835 on government surveys at Green Bay, then in Wisconsin Territory; after serving a time in the territorial legislature he was attracted towards the newly settled Milwaukee, and journeyed thither on horseback. He became the first city engineer of that place and, with Joshua Hathaway, surveyed what is the oldest part of the present populous city of Milwaukee. In 1849-50, he was employed in locating the railway line from Milwaukee to Waukesha; this was a part of the Milwaukee & Prarie du Chien R. R., and MR. EDGERTON was made chief engineer and later superintendent and paymaster until the road was absorbed into the Chicago, Milwaukee & St. Paul system. After this MR. EDGERTON was engineer-in-chief of the following roads: La Crosse, Trempeleau & Prescott, Milwaukee & Fond du-Lac, Kansas City & Santa Fé, and the Milwaukee & Northern railways. MR. EDGERTON then retired, owing to ill-health, and in 1878 settled in Chicago, Ill., where he died.

Contractor vs. Manufacturer.—Messrs. R. J. Malone & Co., who were the contractors for the intercepting sewer at Philadelphia, Pa., gave a contract last year to R. D. Wood & Co. for iron pipe to the value of $11,000. The pipe was to be laid in the bed of the Schuylkill Navigation Company's canal, and the contract stipulated that it should be shipped by water and delivered at the point where it was wanted before the 1st of January, 1886. Owing to delays in the manufacture the plaintiffs were unable to deliver it. The contractors were under heavy bonds to the city to complete their work by March 16, 1886. Navigation ceased on the canal about Christmas, before any of the pipe was delivered. Malone & Bro. were then in a position to declare that the plaintiffs had broken their contract and to refuse to accept any further delivery of pipe. The adoption of this course, however, would have compelled them to violate their contract with the city, as no other firm could have manufactured and delivered the pipe soon enough to have allowed of the completion of the contract within the specified time. They therefore ordered the pipes to be shipped by the Philadelphia & Reading R. R. to East Manayunk, and carted them down to the canal at an expense of $2,000. This amount they claimed to set off against the plaintiffs' demand. The referee has decided against their claim, saying: "They waived the breach and agreed to a substituted method of performance. The defendants' case is a hard one, for they have been put to very considerable expense through no fault of their own, but legally they have precluded themselves from maintaining any defense to the plaintiffs' claim." He therefore makes the award in favor of R. D. Wood & Co. for the full amount of their claim with interest.

Levee.—Taylor, Duffin & Co., Memphis, Tenn., have been awarded a contract for 18 miles of levee work, at $100,000.



NEW CROTON AQUEDUCT: PROGRESS PROFILE, Dec. 1, 1886.

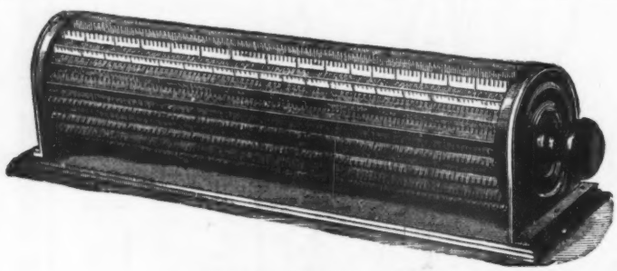
See Page 408

Thacher's Calculating Instrument or Cylindrical Slide Rule.

It is very seldom indeed that we can recommend to our readers anything so confidently as we do this instrument; for in our opinion it is one of the most useful inventions of modern times. Although the principle upon which it is based is by no means new, the application thereof has been so extended as to almost entitle the inventor to the credit of having designed something entirely original.

While the ordinary slide rule, which is 12 inches long, has radii of only 11 and 5½ inches, this instrument has radii of 60 and 30 feet; and while the ordinary slide rule reads to two or three figure this one reads to four and five. The accuracy has, therefore, been increased nearly one hundred fold.

The inventor, Mr. Edwin Thacher, Chief Engineer of the Keystone Bridge Company, has spared neither time trouble nor money to make his instrument absolutely reliable. Some idea of the magnitude of his undertaking may be had by considering that it contains over 33,000 divisions, all made so accurately as to allow no error exceeding one ten thousandth of an inch, also 17,000 engraved figures. The work was executed by W. F. Stanley, of London, upon a dividing machine made expressly for this rule, the diamond point used for cutting the divisions being moved by a screw of fifty threads per inch, reading by micrometer to 0.0001 inch. The framework is of metal throughout, therefore not injuriously affected by variations in temperature or by moisture.



The Thacher Cylindrical Slide Rule.

The instrument which is represented in the accompanying figure consists of a cylindrical slide 4 inches in diameter and 18 inches long, provided with a knob at each end, and admits of both rotary and longitudinal movement within an open framework or envelope of equidistant bars of triangular section. The bars are connected with rings at their ends which admit of rotation within standards attached to the base. The surface of the slide is exposed in the openings between the bars, the lower edges of which are in contact with it. The surface of the slide and the inclined sides of the bars are covered with decimal scales, and the use of the instrument consists in the setting and reading of these scales, a simple operation readily performed.

The diameter and length of slide and the number of bars may be varied at pleasure, but in the present instrument the slide is 4in. in diameter and has a divided length of 18in., and the envelope contains 20 bars. Upon the slide are wrapped two complete logarithmic scales, one on each side of the centre. Each scale from 100 to 1000 is divided into 40 parts of equal length; the number of parts equals the number of exposed sides of the bars, and the length of each is one-half the graduated length of the slide. These parts follow each other in regular order around the cylinder, both on the left and right, and those on the right follow those on the left in regular order. The figures and divisions which constitute any part on the right are repeated on the left one line in advance. All figures and divisions on the scales are made to face both ways, that they may be read from either edge of the bars. Upon the lower lines of the bars, and in contact with the slide, are two other scales of the same length, and arranged in the same manner as those on the slide, there being a complete scale both on the left and right of the center. When the commencement of the scales on the slide and envelope are in contact all divisions on the one are opposite corresponding divisions of the other. Upon the upper lines of the bars, and not in contact with the slide, is a scale of roots. This scale is double the length of the others, and is divided into double the number of equal parts, It occupies the entire upper part of the bars, both on the left and right of the dividing center line. These parts are laid off in regular order, and in such manner that any number on the lower line of bar is the square of the number on the opposite to it on the upper line, and any number on the upper line of bar is the square root of the number opposite to it on the lower line. For numbers having 1, 3, 5, etc., or an odd number of places, their roots are found on the left, and for numbers having 2, 4, 6, etc., or an even number of places, their roots are found on the right. By the rotary movement of the slide any line on it may be brought opposite to any line on the envelope, and by the longitudinal movement any graduations or subdivisions of these lines may be brought opposite to, or in contact with, each other. One-fortieth of a revolution is equivalent to 9in. of longitudinal movement.

When the slide is set in position for use the divisions on it appear of about equal length on both edges of the of the bars, and two lines of figures marking their values appear in each opening betwe enthe bars, two similar lines also being covered by each bar. The divisions on the upper lines are transferred to the slide by means of a pointer fitting over the bars. This pointer is also convenient for retaining the position of any division on either line while the slide is being revolved into the required position. Near the commencement of each scale on the envelope and slide is a heavy black mark, designed to readily catch the eye during the rapid movement of the parts. The former will be found to expedite multiplication, and the latter division.

The object of the instrument is to overcome the drudgery of calculation and accomplish rapidly by mechanical means otherwise tedious arithmetical solutions. It is designed for the use of engineers, architects, actuaries, scientists, accountants, mechanics and business men generally. The useful applications of the instrument are as general as the fundamental rules of arithmetic. Examples in multiplication, division, proportion, powers and roots, involving not more than three quantities are soluble by one operation and any number of values of a single variable are found by one setting of the instrument, a matter of great importance in prorating.

Indeed it would be difficult to say too much in its praise. In this opinion we are upheld by testimonials from many engineers, manufacturers and others. The instrument costs only $30 and will pay for itself in a very short time.

American Society of Civil Engineers.

At the meeting of the Society at their house on Wednesday evening, December 15, the Secretary read a paper by Robert E. McMath on "Determination of the Size of Sewers," in which the author suggested new formulæ and presented a series of four tables giving the discharge of sewers of varying slopes from 1 to 20 feet diameter, data from St. Louis sewers, a comparative table as deduced from various rules and tables of pipe sewers with hydraulic factors.

The Secretary then read a paper by James B. Francis, Past President of the Society, on "Stoppage of Flow in a Water Main by Anchor Ice"; this paper detailed experience with a 12-inch, cement lined water main seven miles long at St. John's, New Brunswick. The discharge from the reservoir was 300,000 gallons in twenty-four hours entering the main by a copper rose with quarter-inch holes; the anchor or needle ice formed on the surface of the water and was carried to this rose by eddies and currents until the discharge pipe was completely closed and the supply cut off. The author entered into a very full discussion of the difference in temperature between the air and water in the main and in the reservoir, deducing therefrom reasons for the ice-formation.

Mr. Chas. B. Brush related a somewhat similar experience at the Hoboken Water-Works and described his method of getting rid of the ice; and Mr. B. S. Church detailed a still more remarkable case in which, in 1871. the Croton Lake mouth of the Aqueduct had been two-thirds closed by ice; in this latter case the ice formed in the free mouth of the aqueduct in a current of over 2 feet per second and without bars, screens or rose upon which to gather, as in the other two cases. In each of these experiences there had been a rapid and decided fall in the temperature just preceding the trouble.

Mr. Theodore Cooper remarked that there might have been other natural causes at work besides the mere fall in temperature; he then stated an experience of his own with a mixture of glycerine and water. Glycerine is popularly supposed not to freeze at all and a mixture of 50 per cent. of glycerine and water was also regarded as safe against freezing. He had occasion to employ a mixture of four-tenths glycerine and six-tenths water, and found that after an exposure to a temperature of about 20° F. the compound in the tank separated, the water froze and the glycerine had formed an almost solid chrystalline mass at the bottom; the peculiar feature was that though the outside temperature had raised to 40° for several weeks afterwards the glycerine retained its semi-solid form. A continuous agitation of the mixture in the tank keeping the glycerine and water thoroughly mixed, would probably have prevented any trouble from freezing.

A NOVEL method of measuring the deflection of railway bridges has been tried in Russia. An iron pipe 1¼ in. in diameter was carried along the outside of one girder. From this pipe, at each abutment and the pier, and at five intermediate points on each span, vertical pipes of the same diameter branched out. Inside, and near the top of each vertical pipe, was fixed a graduated ¾ in. glass tube, the iron pipe being cut away on both sides. The zero divisions on the tubes were all the same distance above the flange of the girder. Before the bridge was loaded the apparatus was filled with water, the tops of the upright pipes covered over, and the water was then drawn off until it stood at zero in each gauze. On the bridge being loaded the deflection could be read with ease.

WATER.

At Jamestown, N. Y., complaints have been made of the quality of water supplied by the water company. Dr. Balch, of the State Board of Health, will make an investigation.

AUSTIN, TEXAS.—The vote for the issue of $350,000 for sewers and works was defeated by 600 to 250, a majority of the taxpayers not voting.

At Pittsburg, Pa., the citizens in the high part of the Tenth and Twelfth wards have petitioned for a better water supply; it is proposed to raise the water from the present main by a turbine.

At Pittsfield, Mass., a company is to be formed to control the Benton brook supply; it will be known as the Junction Water-Works Co., and will be incorporated shortly.

Water Supply Items.—A committee of the New England Insurance Exchange will investigate the water supply and fire apparatus of every New England town, and where they do not come up to the standard will raise rates.

BELVIDERE, N. J.—The engine house of the water-works was destroyed by fire December 10th, and the engine and boilers damaged, depriving the city of its water supply. The loss is estimated at $2,000.

OMAHA, NEB.—An extensive system of sewers, comprising three and a half miles of storm and domestic sewer combined, has been completed recently. The contractors were Messrs. Mount & Griffin and the contract price was only $30,000 owing to lively competition.

TO PREVENT ANCHOR ICE.—At Cleveland, O., the Water-Works Board has purchased a boiler to be placed in the water-works crib, where it will be used to force steam into the tunnel inlets and stand-pipe, raising the temperature of the water so as to prevent the formation of anchor ice, and thus prevent another water famine owing to the stoppage of the stand-pipe outlet, such as was experienced last winter.

CLINTON, MO.—A final and satisfactory test of the new water-works was made December 7th. The works were built by a Springfield (Mo.) company, the president of which is Col. P. B. Perkins. The franchise was awarded to him in May and he went to work at once; it was at first intended to obtain a supply from wells, but it is now obtained from Grand river by a main three miles long. There are nine miles of distributing mains, and the total cost has been $9,700.

WATER-WORKS BUILT BY A WOMAN.—At Tarentum, Pa., a water company obtained a charter some few years ago but never did any work. On the Brackenridge farm is a piece of hill land containing numerous and copious springs; Mrs. Brackenridge recently constructed a reservoir on the hill with a capacity of about 1,000 barrels, and laid pipes to the borough line. She secured the privilege of laying pipes in the streets and most of the houses now use the water at a rental of $1 per month for one opening.

EELS IN LONDON WATER MAINS. Sir Francis Bolton, C. E., official water examiner of London, Eng., states in his October report that the complaints about eels in the water mains are practically unfounded. Lately the underground reservoir at Old Ford was thoroughly cleaned and its three miles of 48-inch main emptied; the total result was one-third cubic yard of sand and half a bucketful of eels in this great volume of water. This was one of the reservoirs reported as "swarming" with eels.

JERSEY CITY, N. J.—The Board of Public Works has resolved: "That this Board hereby sanctions the expenditure by the Joint Board on Pollution of Water Supply of Jersey City and Newark of the sum of $2,500, provided the expenditure of a like amount be authorized by the Newark Aqueduct Board, and provided further that said money shall be used exclusively for such expenses as may be incurred in preventing the pollution of the several sources of the water supply of the cities of Jersey City and Newark under the direction of said Joint Board on Pollution."

WASHINGTON, D. C.—The annual report of the Secretary of War states in regard to the increase of the water supply of Washington that the sum provided in the general deficiency appropriation for continuing the work on the tunnel is $395,000. The ultimate cost of completion, however, will probably exceed this amount in consequence of the suspension of the work for six months. It is believed that the amount appropriated in the general deficiency act—viz., $160,000, will be sufficient to complete the reservoir in all its essential features. In relation to the Potomac river improvement, the Secretary expresses the opinion that large appropriations should be made in the early stages of the work. The sum of $700,000 could be profitably expended during the fiscal year ending June 30, 1888.

SHONE SYSTEM OF DRAINAGE.—The Grand Jury having inspected the County Hospital, Sacramento, California, and made a thorough examination of the Shone pneumatic system of drainage reported that this system is not only peculiarly adapted to similar institutions, but by its adoption the heretofore vexed question of drainage for the hospital has been overcome. They were of opinion that the outlay of less than $4,000 in its erection would be amply repaid in the enriching of the county lands around the hospital.

WATER RIGHTS.—At Sacramento, Cal., the Alhambra Addition Water Co. brought suit against Solomon Richardson and others to prevent defendants tapping the company's pipes and taking water for irrigation. The defendants own the land over which the pipes pass; the water formerly ran in an open ditch, but consent was given to its being piped on condition that defendants be allowed a sufficient supply for irrigation; the company now desires to acquire the entire right to the water. The Supreme Court decided that the plaintiff company must not interfere with the rights of the defendent. The order for a new trial was denied.

WATER COMPANIES.—The Fredericksburg Water Co., Fredericksburg, Pa., has been incorporated by John Barto and others. Capital stock, $5,000.

The Huntington Water Co., Huntington, Mass., has been incorporated by B. C. Mudge, Orson G. Stanley and George Alexander.

The Crystal Water Co., Staten island, N. Y., is erecting a new pumping station on the Richmond turpike.

The Camden and Rockland Water Co., Camden, Me., will apply to the Legislature for an amendment to its charter to enable it to increase its capital stock, to issue bonds for extending its works in Camden and Thomaston, and to take water from Fish's and Hobb's ponds.

PHILADELPHIA, PA.—The Sanitary Committee has reported that some other source of water supply should be obtained for Kensington than the Delaware river, which present source has been so often declared dangerous by the Board of Health. As the former plan of pumping the water into a settling reservoir has been abandoned and the impure water is now pumped directly into the mains the committee recommends that the present supply direct from the river be declared a nuisance and that the Chief Engineer of the Water Department be requested to abate the same by storing water in the reservoir before being distributed through the supply pipes.

CLEVELAND, O.—The Board of Councilmen had an animated session December 13. The chief disturbing element was the report of the committee appointed to inspect three new water-works reservoirs. A councilman who owns a stone quarry and did not get as large a contract for furnishing stone for the reservoir as he thought he ought to have received, insisted that an inferior quality of stone had been used, and that the reservoirs leaked. He succeeded in having an investigation. When the 30,000,000 gallons of water in the high surface reservoir was drawn off to enable the committee to make an inspection, the interior stone facing of the clay walls cracked, crumbled, bulged, slipped and went to general wreck. But whether this was due to the sudden removal of pressure or to the collapse of the eight-inch coating of ice on the water or to deficient construction, the committee was unable to decide, and in its reports after relating the facts, suggested that experts be called upon to decide the question.—*N. Y. Times.*

ARTESIAN WELLS.—The Louisiana Artesian Well Co. is boring a sixth well at the Ice Consumer's Factory, New Orleans, La. The other five wells average 410 feet in depth and the new one will probably be put down 700 feet. The water is said to be very pure.

At Sierra Valley, Cal., artesian wells are meeting with great success; a well 750 feet deep was put down in two days at a cost of $45 and flows 80 gallons per day; only 19 feet of casing was required. The water is warm, and when cooled off is excellent for drinking purposes. There are four boring machines in the place.

A company will drive artesian wells at Cedar Key, Fla., and if successful in obtaining water, will erect an ice factory.

At Lebanon, Pa., the committee on the new water supply has reported an additional supply absolutely necessary and favors Little Swatara creek, 6 miles distant, as the source; a reservoir with a capacity of 10,000,000 gallons is contemplated, and the cost of the new works is estimated at $235,400.

The water of the Passaic river, from which Newark, N. J., and Jersey City take their water supply, is badly polluted by the refuse of factories of many kidds. Professor Austin, of Rutgers College, recently analyzed 30 samples of the water taken from different places, and found them all unfit for human consumption. The cities have about $10,000,000 invested in water works, and this amount is likely to be wasted if some measure is not at once taken to ensure the purity of the water supply.

THE MEMPHIS WATER SUPPLY.—The legislative council of Memphis, Tennessee, appointed a committee of ten citizens on July 23, 1885 to consider all matters relating to the water supply of the city. The active duties were performed by Gen. Colton Greene, who made a preliminary report on February 23rd, 1886, and presented his final report on December 1st, which was unanimously adopted by the committee and by them transmitted to the Legislative Council, with their full endorsement and recommendation that the works proposed be constructed by the city, and not entrusted to a private company.

General Greene appears to have investigated the subject of sources and modes of supply in a very thorough manner, and has called to his assistance experts in sanitary, mechanical and engineering science on every point where reasonable doubt could exist. As the final result of his investigations he recommends that water be taken from Wolf river about eleven miles from the city, and pumped nine miles through a 30-inch cast-iron main to a reservoir two and a half miles from the center of the city and about 100 feet above its level. Before entering the reservoir, the water will be passed through a Hyatt filter and aerator. Near the reservoir it is proposed to erect a high-service pump and water-tower, to furnish greater head in the business districts for elevators and fire service. The total cost of the plant and the distributing pipes is estimated at $952,000.

In the preliminary report of February, 1886, General Greene sketches out the system, but desired more time to satisfy himself as to the entire feasibility of several of the features proposed. The sanitary questions he submitted to Dr. Charles Smart, United States Army, and on his exhaustive report based the conclusion that the Wolf river water is the best to use.

The mechanical devices connected with the filtering apparatus proposed by the Newark Filtering Company, were submitted to the criticism of Mr. A. A. Wilson, M. E., of the Quintard Iron Works, New York City, who reported that he could "see no reason why, in a mechanical point of view, the whole plant should not operate practically."

The really vital question to the scheme, whether the plant proposed by the filtering company was capable of clarifying and aerating the Wolf river water, was submitted to Mr. J. J. R. Croes, M. Am. Soc. C. E. From his report, it is plain that, as Gen. Greene expresses it, he "began the examination with characteristic professional distrust of innovations." His conclusions were however, favorable to the practicability of the process proposed and its adaptability to the purpose, though he did not consider the plant specified, as being capable of filtering continuously seven and a half million gallons of Wolf river water, without certain modifications. As regards cost of operation, the conclusion reached is that including interest on the works, the filtration by the method proposed will cost only one-fourth of what it would cost to filter by sand filter beds and he recommends the adoption of the plan as being practicable and economical.

NEW WATER-WORKS.—Albion, Neb. The works are not giving satisfaction, the wells are insufficient in capacity and the creek water is unfit for use.—Meridian, Miss. The Meridian Water-Works Co. is building a 200,000,000 gallon reservoir; laying 9 miles of pipe, 4-inch to 16-inch; setting 90 fire hydrants, and putting up two pumping engines of 1,000,000 and 2,000,000 gallons capacity.—Middletown, Conn. Machinery for the new works is being shipped by the National Water-Works Construction Co., of Dayton, O.—Bath, N. Y. The question of water-works is being agitated.—Streator, Ill. The reservoir will hold 210,000 barrels.—Columbia, Tenn. The water company has laid stronger mains on the line from the pumps to the river, several of the old pipes having burst recently; the reservoir on Mount Parnassus has a capacity of 1,000,000 gallons.—Columbus, Neb. The new works have been tested with satisfactory results; the tank has a capacity of 90,000 gallons.—Livermore Falls, Me. A water supply for fire protection is projected; it is proposed to build a dam across land containing a number of springs and make a reservoir with four or five feet depth of water over an area of about an acre; something will certainly be done next summer.—Argentine, Kan. The Kansas City Water-Works Co. has made a proposition to put in 20 water plugs and furnish water to the city.—Keene, N. H. The estimated cost of the new works complete is $37,000; the present net annual income pays the entire interest on the water and sewer debts, including the debt for the recent extension.—Camden, N. Y. Water has been turned into the pipes of the new works; they cost $36,100 and were built by Sherman & McDonough.—Ashland, Ky. A proposition to build works has been made by the American Water-Works Co.—Pleasant Hill, Mo. Zenas Leonard is constructing a lake with an area of 13 acres and a capacity of 150,000,000 gallons; a complete system of water-works will be put in.—Wabash, Ind. Work is progressing rapidly.—Plattsmouth, Neb.—Owosso, Mich.—Pierce, Neb.—Beaufort, S. C.

STREET NUMBERING.—At Denver, Co'., a new system of street numbers has been adopted '' is known as the decimal system and has been in vogue for some time in several eastern cities. One hundred numbers are alloted to each block and all numbers run from south to north and from west to east. Several street and avenue names have been replaced by numerals. The numbers are being put up as rapidly as possible. The law went into effect on December 1st, and a fine of $5 is imposed for non-compliance within a reasonable time. The entire cost of the new system will not exceed $6,000.

FREEPORT, ILL.—The new water supply for the water-works has now been secured. For the four years the works have been in operation the supply has been drawn from a well and was sometimes quite cloudy. This source has now been abandoned, and the new supply is taken from a group of eighteen small artesian wells averaging about 42 feet in depth; they are driven at intervals of 20 feet; 17 are 3 inches in diameter and one is 2 inches in diameter. Each well is connected by pipes to a 16-inch cast-iron main from which the water is drawn by the low-pressure pumping engine. The 3-inch wells flow about 300 gallons per minute and the 2-inch well about 165 gallons per minute, making a total of about 7,500,000 gallons per day. The works now pump about 600,000 gallons per day, and when an increased supply is required new wells can be driven. The water is soft and pure and an analysis gives the following: free ammonia, 0.02 parts per 1,000,000; albuminoid ammonia, 0.04 parts per 1,000,000; chlorine, 5.60 parts per 1,000,000; total solids, 23.732 grains per U. S. gallon. The work has been done under the supervision of F. E. Josel, superintendent.

JERSEY CITY, N. J.—The acceptance by the Board of Works of the offer of the North Jersey Water Company to supply Jersey City with water, has aroused great interest throughout the city. The offer of the company is to supply the city from the Pequannock river with water at $38.50 per million gallons; to pump it into the city's reservoirs, and to allow the city to furnish Bayonne and the other districts it supplies with water, at the same rate. The contract to last for ten years. The acceptance yet needs the concurrence of the Board of Finance, who will doubtless hesitate and carefully inquire before concurring. The drinking water supplied to Jersey City is about as vile as drinking water can be, but many citizens believe that it has been allowed to run into the mains in as filthy a condition as possible with a view to preparing public sentiment for the acceptance of this proposition. The water is not filtered, nor is any attempt made to cleanse or purify it. A proposition has recently been made to put in a filtering apparatus that would make the water much more palatable and wholesome than it is. The Board of Works has had unlimited control of the water moneys. They are responsible to no one, and the public dissatisfaction with the expenditure of these moneys, is used as an argument in favor of having the control of the water-works taken out of their hands. The Water Department should, it is contended, if properly administered, net the city a large income. Instead of that there has not been a year lately when the water receipts have not run behind the disbursement. It is estimated that the cost to the city of the water service is $63 per million gallons, and the proposition that it be let out to private parties is justified on the ground of economy. At the same time the water-works represent several millions of dollars of city assets, and it is argued that the parting with the control of the city's water franchises will practically destroy the value of their property.

List of New Water Works.

Projected or completed, or extensions, mentioned in ENGINEERING NEWS July 1st to Dec. 11th 1886.

The following list of new water works will not appear in our semi-annual index, by reason of the notes referring to them having been published in our advertising pages. We print them in the order in which they were published rather than alphabetically, for ease of reference: the works noticed from January to July are indexed in that volume. The following is the list commencing July 3rd.

Throckmorton, Tex., Yankton, Dak., Lockhart, Tex., Janesville, Minn., Westcliffe, Colo., White Plains, N. Y., Galveston, Tex., Rapid City, Dak., Richmond, Me., Cape May, N. J., Iroquois, Can., Moesic, Pa., Nashville, Ark., Rome, Ga., Highland, Colo., Rico, Colo., Pensacola, Fla., Kearney, Neb., Shelbyville, Ills., Circleville, O., Gainesville, Fla., Canastota, N. Y., Turner's Falls, Mass., Lake Charles, La., Elgin, Ills., Fishkill, N. Y., Chatham, Va., Bath, Me., Hastings, N. Y., Malden, Mass., Martha's Vineyard, Mass., Clinton, Mo., Chatham, W. Va., Wauwatosa, Wis., Dalton, Ga., Key West, Fla., South Paris, Me., Chadron, Neb., Hudson, Wis., Highmore, Dak., Orlando, Fla., Pittsburg, Pa., Rockville, Conn., Galena, Ill., Hillsborough, N. H., Beloit, Wis., Green Bay & Fort Howard, Wis., Ellsworth, Kan., East Greenwich, R. I., Danielsonville, Conn., Memphis, Tenn., Warsaw, Ind., Cobleskill, N. Y., Phenix, R. I., Sterling, Ills., Gadsden, Ala., Paris, Tex., Emporium, Pa., Niles, Mich., Keeseville, N. Y., Hanson, Mass., Bennett, Neb., Bristol, Tenn., Burlington, Kan., Baldwinsville, N. Y., Lyons, N. Y., Dover, Farmington, Rochester and Great Falls, Me., Salem, Ind., Del Norte, Colo., Dodge City, Kan., Waterloo, Ia., Covington, Ky., Salisbury, N. C., Marblehead, Mass., Warren, O., Brownwood, Tex., Long Pine, Neb., Concordia, Kan., Minneapolis, Kan., Greenville, S. C., Jefferson, Ia., Sanborn, Ia., Plainwell, Mich., Independence, Ia., West Superior, Wis., Owosso, Wis., Deland, Fla., Herkimer, N. Y., Kirkwood, Mo., Milledgeville, Ga., Murfreesboro, Tenn., Vicksburg, Miss., Holden, Mo., Lackawanna, Moosic, Pleasant Valley, Pa., Round Lake, N. Y., Garden City, Kan., Camden and Rockland, Me., Catonsville, Md., Portland, Ore., Sheboygan, Wis., Eufaula, Ala., Palmer, Mass., Brunswick, Me., Pomeroy, O., Gainesville, Fla., Burlington, Mich., Hastings, Mich., Neligh, Neb., Oskaloosa, Ia., Schenectady, N. Y., Paducah, Ky., Bar Harbor, Me., Biloxi, Miss., Ballinger, Tex., Goldsboro, N. C., Hamilton, N. Y., Kane, Pa., Newport, Ky., Ocala, Fla., Eustis, Fla., Corry, Pa., Latrobe, Pa., Hobart, N. Y., Pelham, N. Y., Greensburg, Pa., Champlain, N. Y., Northfield, Minn., Waterville, N. Y., Round Pond, N. H., Exeter, N. H., Texarkana, Tex., Mobile, Ala., Sunapee, N. H., Gloversville, N. Y., Lincoln, Neb., Thomasville, Ga., Louisiana, Mo., North Amherst, Mass., Austin, Tex., Luzerne, Pa., Harper, Kan., Wyoming, Pa., Missouri Valley, Ia., Lebanon, N. H., Ybor City, Fla., Greenwich and Easton, N. Y., Babylon, L. I., Huntingdon, W. Va., Carlisle, Ills., Lockport, N. Y., Holbrook, Mass., Marietta, Ga., Monticello, N. Y., Coshocton, O., Coldwater, Mich., Bradford, Mass., Middleton, Del., Baraboo, Wis., Escanaba, Mich., Fort Fairfield, Me., Presque Isle, Me., Hastings, Dobb's Ferry and Irvington, N. Y., Dayton, O., Whitman, Mass., White Sulphur, O., Pine Bluff, Ark., Harrisburg, Pa., Independence, Ia., Meridian, Miss., Sterling, Kan., Genesco, N. Y., Helena, Minn., Pendleton, Ore., Belfast, Me., Oberlin, O., Chilicothe, Mo., Rochester, Minn., Cornish, Me., Joliet, Ills., Livermore Falls, Me., Foxboro, Mass., Sheboygan, Wis., National City, Cal., Franklin, O., Pennington, N. J., Eastport, Me., Green Island, N. Y., Huntington, Mass., Sturges, Dak., West Randolph, Vt., Manitowoc, Wis., Holmesburg, Pa., Osage City Water Co. N. Y., Miner's Mills Water Co. Wilkesbarre, Pa., Larned, Kan., Charles City, Ia., Marietta, Ga., Bartlett, N. H., Lebanon, Tenn., Punxsutawney, Pa., Belmont, Mass., Windsor, Vt., Bellevue, Ky., Bennington, Vt., Pleasant, Hill., Mo., Lincoln, Me., Live Oak, Fla., Griffin, Ga., Boothbay, Me., Baton Rouge, La., Jackson, Miss., Dover and Foxcroft, Me., Spring Valley, Ills., Centerville, Md., Eureka, Cal., Natchez and Jackson, Miss., Westerly, R. I., La Grange, Ga., Kearney, N. J., Guthrie, Ky., Waukesha, Wis., Palatka Heights, Fla., Huntsville, Ala., Montclair, N. J., Gettysburg, Dak., Storm, Lake, Ia., Vincennes, Ind., Bridgewater, Mass.

Buildings.

Residences.—Architects Donnellan & Nothnagel, 24 Mallers building, Chicago, have planned a block of three residences for T. Thomas, to be erected on A land avenue at a cost of $16,000. Walls of pressed bric stone trimmings, galvanized iron furnace heat, pl glass, mantels and laundry fixtures.

Plans have been prepared by architect P. W. R [illegible] 565 South Canal street, Chicago, of a two-story residence for Dr. Tirka, to be erected on West Taylor street at a cost of $10,000. Exterior of pressed brick, stone, galvanized iron, furnace heat, electric bells, mantels, etc.

Schoolhouses.—Architects Hadley & Cooper, of Topeka, Kan., are engaged on plans of two schoolhouses to be erected at Russell, Kan., at a cost of $17,000. Materials, stone, two-story each, one 26x57 and the other 65x73 feet.

Lake View, Ill., will have three new schoolhouses for which an appropriation has been made. They will be built of brick, stone and galvanized iron; with furnace heat, etc.

U. S. Court House and Post Office.—Messrs. Clark, Raffen & Co., of Chicago, have been awarded the contract for the iron work for first floor of the new Government building at Macon, Ga.

Store and Office Building.—Plans are being drawn by architect A. Russell, Syracuse, N. Y., for an eight-story store and office building, to be erected in that city for C. W. Snow; 32x152 feet. It will be fire-proof throughout with all modern improvements. Work to begin May 1, and completed January 1, 1888.

Factories.—Warren Springer, 207 South Canal street Chicago, will erect a five-story and basement factory, 50x100 feet, at 198 to 200 South Clinton street, to cos about $40,000 Pressed and common brick, stone trimmings, elevator, steam power and machinery and fixtures.

The D. Bradley Manufacturing Co, is building a two-story addition to their extensive works, 59 and 63 Fulton street, 60x10 feet; cost about $15,000. Common brisk, galvanized iron, machinery and fixtures.

Depot.—The Chicago, Milwaukee & St. Paul R. R. Co. will move into the new passenger depot, Milwaukee, Wis., December 19. It is one of the finest structures of the kind in the west, and has cost about $600,000. Messrs. E. T. Mix & Co. Milwaukee, are the architects

Cost of Break of Gauge.—The cost of transfer of freight at the boundary line of New South Wales and Victoria (Australia), necessitated by the difference of gauge of the railroad systems of the two colonies, is said to be about 20 cents per ton.

NEWS OF THE WEEK.

Contracting.

City Work.—The following proposals were opened at the Department of Public Works, New York City, December 16: (1) Regulating, grading, curbing, guttering and flagging on 97th street from the Boulevard to River Drive, John Brady, $3,504.49; Wm. Kelly, $3,756.76; Matt. Conley, $4,110.56; John J. Farley, $4,528.85; James Slattery, $4,919.17; Thomas E. Crimmins, $5,166.74, John B. Devlin, $5,519.45; James Leeson & Ben. Carr, $5 641.95; J. H. Sullivan, $6,012.38; T. J. McManus, $6,304.16; John Cox & Co., $6,424.02; L. W. Johnson, $6,597.80; John Slattery, $7,398.66.

(2) Curbing, guttering and flagging, on 90th street from Eighth to Ninth avenue, Cornelius Ward, $1,958; James Slattery, $2,116; D. W. Moran, $2,156; John Slattery, $2,159; John B. Devlin, $2,231; John Cox & Co., $2,311; W. Murfay, (informal).

(3) Sewers in 72rd street between Hudson river and Eleventh avenue, with branch in Riverside avenue between 72nd and 76th streets, James Slattery, $26,205; John McKim & Son, $26,213.10; G. M. Dean, $30,253; John McQuade $31,480.

Timber, Stone and Iron.—The following proposals were opened by Major S. Cooper Overman, U. S. Engineer Office, Cleveland, O., December. 13, for constructing 1,200 feet of the East Breakwater at Cleveland: Timber and stone,—Charles E. Williams, Buffalo, N. Y., hemlock timber, $19.50 per 1,000 feet B. M.; white pine timber, $31.50; white oak timber, $33.91; foundation stone, 4.90 per cord, rip-rap stone, $1.20 per ton; trenails $20; total $110,315.54. L. P. & J. A. Smith, Cleveland, O. $22, $28, $30, $5.50; $1.50, $5; $118,181. F. H. Eggers Cleveland, O., $24.75, $30, $40, $7, $2.60, $6 50; $149,368.50 J. S. Johnson, Fulton, N. Y., $25, $38, $5, $7, $2.60, $7; $157,819. The contract has been awarded to Charles E. Williams. Iron.—Charles W. Scofield, Cleveland, O, plates and angle plates, 3¾ cents per pound; bolts 3¼ cents; drift, bolts, 2¼ cents; button-head bolts, 3 cents; boat spikes 2¾; strap iron, 3 cents per pound; bands with hinged ends, $1.19; bands with hinge and angle, $1.64; tie-rods $2.88; turn buckles, $1.13; total, $8,478.54. William M. Pattison, Cleveland, O., 3¼ cents, 3, 2¾, 3¼, 2.45, 2¼, $2.75, $3.25, $2.75, $1.10; total, $8,579.10. A. Lacour, Cleveland O., 3 cents, 3, 2¼, 6, 2¾, 2½, $3, $3, $4.62, $1.20; total, $9,173.89. The contract has been awarded to Charles W. Scofield.

Jetty Work.—The following proposals were opened December 11th by Lieut. W. M. Black, U. S. Engineer Office, Jacksonville, Fla., for the construction of jetties at the mouth of the St. John's river: mattresses, 37,000 square yards: stone 40,000 tons: Rittenhouse Moore, mattresses, 45 cents; stone, $2.45; total, $114,650. R. G. Ross, 51 cents, $2.70, $127,980. James A. Bryan, 49 cents, $2.87½, $133,130. John F. Gaynor, 78¾ cents, $3.60, $173,045.

Sewers.—James F. McBride has been awarded the contract for a sewer at Wilmington, Del.; to be laid partly with iron pipe.

Contracts for sewers at Pittsburg, Pa., have been awarded as follows: Gallagher, $2.23 per foot; manholes, $40 each; drops, $65 each; C. & M. Ott, $2.20 and $2.45 per foot; manholes, $30 and $35; drops, $55, $60 and $65; masonry, $11 and $12 per cubic yard; concrete, $5 and $7 per yard; 20-inch pipe, $1.85 per foot, 15-inch pipe, $1.10.

Contracts for sewers at Paterson, N. J., have been awarded to Robert Downie at an aggregate of $2,175.75, and to Messrs. Cranford & Collins at $677.50.

Street Cleaning and Garbage Removal.—The following bids have been received by the Board of Public Works, Jersey City, N. J., for cleaning about 750 miles of streets and removing garbage, next year; J. H. Keeney, sweeping and cleaning, $19 per mile; removing ashes, $8,000; removing garbage, $4,000. F. C. Meehan, sweeping and cleaning, $31; removing ashes, $11,000; garbage, $8,000. H. Byrne, sweeping and cleaning, $15; removing ashes, $12,000; garbage, $5,000. George F. Swift, sweeping and cleaning, $5; removing ashes, $16,000; garbage, $4,000. J. M. Mailly, sweeping and cleaning, $24, removing ashes, $14,000; garbage, $1,000. Dennis Burns, sweeping and cleaning, $20; removing ashes, $9,700; garbage, $5,300.

Iron-Works.—The following proposals were received for the iron-work at the court-house, Louisville, Ky.: Snead & Co. Iron-Works, $19,400, Fred. J. Meyers, Manufacturing Co., $22,500; Scherpe & Koken., $24,995; M. A. Sweeny & Bro., $26,000. The contract was awarded to Snead & Co.

Excavation and Canal Wall.—The following proposals have been received by Major Amos Stickney, U. S. Engineer Office, Louisville, Ky., for work on the Louisville & Portland canal: Excavation (enlarging basin); Donald Macdonald, earth, 35 cents per cubic yard, rock, 98 cents; Francis H. Smith, 45 cents, $1.70; C. I. McDonald, 42 cents, $1.10; Roderick McKenzie, 32 cents, $1.40; Stephen M. Williams and Roy DeDonald, 36 cents, 95 cents; Patrick E. Roach and George W. Lewis, 44 cents; $1.29; Marshall Morris and T. H. McMichael, 27 cents, 90 cents; John J. Shipman & Co., and A. J. Shipman, 34 cents, 82 cents, John D. Lyle and Frederick Dahm, 24 cents, 80 cents; Gleason & Gosnell; 17.5 cents, $1.05.

Canal wall, 9,000 cubic yards: Horace Scott, Louisville, Ky., and Henry F. Holmes, Indianapolis, Ind., $11.25 (A) and $16 (B) per cubic yard; John J. Shipman & Co., Newport, Ky., $13; David Y. Johnson, Bedford, Ind.; $10.70; Wm. F. Shanks, Louisville, Ky., $11.50; Salem Stone & Lime Co., Louisville, $10.43; Francis H. Smith, New York City, $11.44; Marshall Morris and T. H. McMichael, Louisville, $13; Patrick E. Roach and George W. Lewis, Cincinnati, O., $13.48; C. I. McDonald, Pittsburg, Pa., $14.34; Scott Webber, Bedford, Ind., $18.27; Donald McDonald, Louisville, $11.92; Thomas Munford, Niagara Falls, N. Y., $10.89; I. Hoag, Jr., Pittsburg, Pa., $13.24.

Brooklyn Navy Yard.—Secretary Manning has recommended the following appropriations: improving Whitney basin, $75,000; repairing Cob dock, on Wallabout channel, $75,000; timber dry dock, $700,000; paint and oil storehouse, $35,000; packing house, $48,642; caisson gate dry dock, $33,000; boiler shop, $68,340; total, $1,023,982.

Railroad Contracts.—Contracts for one and two miles respectively have been awarded to Thomas F. Kerns and Edward J. Gaynor for a link of the Pennsylvania Schuylkill Valley R. R., from Frackville to near Mahanoy City, Pa., a distance of three miles. It will connect with the Lehigh Valley R. R.

The contract for the construction of the Mahoning & Shenango Valley R. R., an important branch of the Lake Shore & Michigan Southern R. R., has been let to Fleming & Co., of Cleveland, O.; work has been commenced and will be finished in June.

The contract for the trestle work of the Fort Worth & Rio Grande R. R., between Fort Worth and Granbury, has been awarded to Arch Smith, Granbury, Tex.

The contract for 50 miles of grading for the Colorado Midland R. R., between Hilltop and Leadville, has been awarded to Streeter & McMurtrie, W. C. Bradbury & Co., and C. Lipe & Co. The entire line is now under contract and work is progressing rapidly. The section from Colorado Springs to Eleven Mile cañon, on the Platte river, 40 miles, including nine tunnels, is ready for tracklaying. The contractors were the two first named firms.

Bridge.—The contract for an iron bridge at Louisville, Ky., has been awarded to E. F. Madden & Co., at $8,250.

The Roanoke Construction Co. has been incorporated at Roanoke, Va., to undertake mining and railroad construction. The company will build the railroad from Roanoke to New Castle. President, D. F. Houston: Vice-President, H. S. Trout; Secretary, S. W. Jamison.

Cruiser.—Secretary Whitney has decided to give the contract for building the machinery, boilers and hull of twin-screw vessel of 1,700 tons displacement and 3,300 I. H. P., to Cramp & Sons, of Philadelphia. This is Gunboat No. 1.

The Garfield Monument.—Owing to defective engineering the base of the Garfield Monument at Cleveland, O., proved unequal to the weight which it was to have borne. Brick was largely substituted for stone and the monument was made one-third smaller than the original design. The contractor is now sued by the men to whom he gave the task of carting the stone from the railway. There were to have been 1,100 carloads of stone, but when the sub-contractor had delivered 412 the contractor told him to bring no more.

The Union Iron-Works, of San Francisco, Cal., which will build Cruiser No. 2, the *Charleston*, on their bid of $1,017,500, have closed a contract with the Canadian Pacific Navigation Company, of Port Moody, for a 1,500-ton steel steamer to cost $200,000, to be run in connection with the Canadian Pacific Railroad.

The Union Iron Works, besides the caisson for the Government dry dock and some steam colliers, have been engaged to a great extent in building mining and pumping machinery. Their largest piece of machinery is probably the pumping engine at Virginia City, Nevada; it is a compound engine, cylinders 65 and 100 inches diameter and 12 feet stroke, pumping from a depth of 3,100 feet, with a duty of 93,000,000 foot-pounds per 100 pounds of coal. This engine was entirely of California manufacture and was built and running within six months.

Dredging, Dikes, Jetties, Etc.—The following proposals have been received by Lieut. Col. Wm. P. Craighill, U. S. Engineer Office, Richmond, Va., for improving the James river: the work consists of (1 Dredging sand and gravel, (2) Excavating disintegrated rock, (3) Excavating solid rock, (4) Mattress dikes, (5) Jetties (6) Extension of Jetties: H. B. Culpepper, Portsmouth, Va., (1) 19.5 cents per cubic yard, total, $9,750.—J. L. Johnson, Fulton, N. Y., (1) 28 cents, $14,000; (2) $2, $500; (3) $12, $27,000.—Joseph Allard, Richmond, Va., (4) $8.30 per lineal foot, $83,000; (5) $6.47, $12,940; (6) $6.47, $12,940.—Sylvester & Rowe, Boston, Mass., (1) 30 cents, $15,000 (2) 50 cents, $125; (3) $15,$33,750.—John F. Gaynor, Savannah, Ga., (3) $5.49, $54,900; (5) $5.10, $10,200; (6) $5.19, $10,380.—Atlas Dredging Co., (1) 21 cents, $10,500.—Rittenhouse Moore, Mobile, Ala., (1) 21 cents, $10 500; (2) $3.40, $850; (3) $7.80, $17,550; (4) $4.27 $42,700; (5) $4.27, $8,540; (6) $4.27; $8,540; total for entire work, $88,680.—Langhorn & Lampkin, Richmond Va., (1) 21 cents, $10,500; (2) 50 cents, $125; (3) $11, $24,750; (4) $5, $50,000; (5) $4.20, $8,400; (6) $4.25, $8,500, total, $102,275.—American Dredging Co., Philadelphia, Pa., (1) 25 cents, $12,500; (2) 50 cents, $125: (3) $20, $45,000; (4) $5.67, $56,700; (5) $5.14, $10,280; (6) $6, $12,000; total, $136,605.—P. Sanford Ross, Jersey City, N. J., (1) 22 cents, $11,000; (2) $2, $500; (3) $15,$33,750; (4) $9,02 $90,200; (5) $7.71, $15,420; (6) $7.71, $15,420; total, $166,290.

Main Drainage.—E. F. Brigham, of Somerville, Mass., the lowest bidder for Section 6 of the Boston main drainage works (see page 367) having declined to sign the contract, the work has been awarded to Messrs. Putterill & Killian, of Boston, the next lowest bidders, for $13,230.50.

Pipe.—The Water Commissioners, Albany, N. Y., will open proposals to day for delivering 6,500 feet of 12-inch, and 7,000 feet of 6-inch mains. Delivery to be made next spring. George W. Carpenter is Superintendent.

Sewerage.—Messrs. Duffett & Ramsay have been awarded the contract for putting in a system of sewerage at Lincoln, Neb. J. M. Young is superintendent.

Earth Filling.—The following proposals have been received at the Engineer Office, Washington Monument, for earth filling around the base of the monument, Washington, D. C.: P. B. Pulman, Washington 63 cents per cubic yard: J. Lerch, Washington, 35 cents (informal); Gilbert Peterson and James F. Barbour, Washington, 78 and 47 cents (provisional); T. H. Lyons, Baltimore, Md., 49 cents.

Ties and Wood.—Messrs. Egan Bros., Winnipeg Manitoba, have been awarded the contract for 175,000 ties, and 10,000 cords of wood for the Canadian Pacific R. R. Co.

Levee Work.—The following proposals have been received by Capt. Smith S. Leach, U. S. Engineer Office, Memphis, Tenn., for work on the Mississippi—Yazoo Delta Levee District; approximate amount, 400,000 cubic yards; all the bids were from Memphis parties: Daniel T. Hartnett, Sections 15, 16, 17, 18,—earthwork, 21.5 cents per cubic yard; felling timber, $50 per acre. Michael McTighe, Sections 15, 16,—26 cents. $35. P. F. Lamb & A. Donnelly, entire work,—23.75 cents, $55. J. J. Cooney, Sections 18, 19, 20,—25 cents, $50. Hugh Feran & M. C. Pearse, Section 18,—25 cents, no bid. George & A. A. Arnold, Sections 15, 16,—33 cents; 17,—30 cents; 18,—22 cents; 19, 20,—28 cents; 21,—26 cents; 22 to 27,—22 cents; $50. Contracts were awarded as follows: Sections 15 to 18, Daniel T. Hartnett; 19 and 20 J. J. Cooney; 21 to 27 (inclusive), G. & A. A. Arnold.

Dredging.—The following proposals have been received by Col. G. L. Gillespie, U. S. Engineer Office Boston, Mass.; all the bids were from Boston firms: Bay State Dredging Co., 15 cents per cubic yard, measured in scows; Boynton Brothers, 19.5 cents; New England Dredging Co., 19.5 cents.

Capt. F. M. Pippo has offered to dredge out the Falaya bayou to secure a depth of 5 feet of water to Covington, La., for $2,000. The appropriation for the work is $2,500.

The amount appropriated for dredging Jones's falls, at Baltimore, Md., has now been exhausted, but as it would be a great loss to the city to stop work, owing to the fact that the portion already cleaned out would soon fill in again, it has been decided that the Baltimore Dredging Company shall continue with the work. It is estimated that it will require $15,000 to continue the dredging up to Gay street bridge, and the dredging company have concluded to continue the work and wait for the money until the council meets in January. The mayor and members of the city council are willing that such arrangement should be made.

Mississippi River Improvement.—Major Wm. H. Heuer, U. S. Engineer Corps, has made surveys and estimates for a navigation route from the Mississippi, through Plaquemine bayou, and up the Grand and Atchafalaya rivers. The estimate for the excavation is made from the cross sections of Plaquemine bayou on the basis for a channel 150 feet wide on the bottom and a depth of 5 feet at low water, with side slopes of three horizontal to one vertical, and the curvature limited to a minimum radius of 1,500 feet on the center line.

The lock chambers show a length of 300 feet, between the gates, with a width of 75 feet. The plan provides for a guard gate at the Mississippi entrance.

AGGREGATE COST OF ROUTE.

	Brick Locks. Grand river, channel 200 ft.	Grand river, channel 150 ft.
Locks	$531,550	$531,550
Bayou excavation	782,700	782,700
Grand river	286,000	145,800
Removing raft and snags in Atchafalaya	108,000	108,000
Total	$1,708,250	$1,568,050
	Concrete Locks.	
Locks	$479,600	$479,600
Bayou excavation	782,700	782,700
Grand river	286,000	145,800
Removing raft and snags in Atchafalaya	108,000	108,000
Total	$1,656,300	$1,516,000

Pumping Engines.—The following proposals have been received by the Water-Works Trustees, Youngstown, O.: Deane Steam Pump Co., Holyoke, Mass.; high-pressure cylinder 24 inches diameter, low-pressure cylinder 44 inches diameter, plungers 22½ inches; $13,980. Gordon & Maxwell Co., Hamilton, O.; 26,46, 22½ inches; $15,000. Wilson, Snyder & Co., Pittsburg, Pa., 24,44, 22½ inches; $15,200. H. R. Worthington, New York City, 21,36¾, 22½ inches; $15,900. Holly Manufacturing Co., Lockport, N. Y., 26,45, 23 inches; $17,500. Each estimate was made for two high-pressure and two low-pressure cylinders and two pump cylinders; and in each case the stroke was 36 inches.

Rip-Rap.—The following proposals for 1,100 tons of rip-rap stone at the middle shaft of the Dorchester Bay tunnel have been received by the City Engineer, Boston, Mass. Joseph E. White, $1.63 per ton: Boynton Bros., $1,75; Thomas Cargill, $2. The contract was awarded to Joseph E. White.

Public Buildings Appropriation.—The Secretary of the Treasury recommends the appropriation of $3,444,014 for public buildings for the year ending June, 1888; this includes the Brooklyn post office, $165,000; Rochester court-house, $100,000; Troy post office, $100,000; Marine Hospital, New York City, $250,000.

Pump, Tank, Etc.—The following bids were opened on Monday at the office of the Board of Education, New York City, for a pump, tank and connections for school No. 8, Mott street: Jeremiah J. Deady, $549; W. G. Patten, $629; John Spence, $663; P. Carnaher, Jr., $688

Street Paving.—In the new appropriation bill for Pittsburg, Pa., the City Engineer's department will have an item of $100,000 for repaving streets. The amount will probably be granted.

Street Cleaning.—At Phiadelphia, Pa., the following contracts for the work for next year have been awarded: 1st district, Oliver Wilson, $49,940; 2nd district, Walter Peterson, $59,300; 3rd district, Dennis McLaughlin, 45,000; 4th district, E. Gannon, $79,000; 5th district, Dennis McLaughlin, $10,500; 6th district, William Lay, 33,900; 7th district, K. Dooley, $18,000.

The amount of money appropriated by Councils for he collection of garbage, ashes, offal and for the caning of the streets is $290,000. The bids amount to 296,540.

Repairs to Piers.—The following proposals were opened at the Department of Public Works, New York City, December 15: Pier 54, North river: John Gillies, $17,132; James D. Leary, $18,240; Barth S. Cronin, $17,500; P. Sanford Ross, $16,500; Joseph Walsh, $17,000. Pier at foot of Bogart street, John Gillies, $7,668; John W. Flaherty, $6,500; James D. Leary, $8,340; Barth S. Cronin, $6,750; P. Sanford Ross, $7,800; Joseph Walsh, $8,000. Pier at foot of W. 19th street, John Gillies, $2,400; Conlan & Ryan, $1,693; John W. Flaherty, $2,400; James D. Leary, $2,340; Barth S. Cronin, $1,700; P. Sanford Ross, $2,400. JohnD. Walsh, $1,274; John Dunn, $1,500; James Smith, $1,829.

Lists of quantities of the engineer's estimate have been given in the *City Record*.

Masonry.—The following proposals for repairing the center pier and abutments of the Hamilton avenue bridge, were opened December 15, at the Department of City Works, Brooklyn, N. Y.: Hugh Hart, $1,650; James Du Bois, $1,800; Richard Cronin & Son, $1,890; John W. Flaherty, $2,100. The contract has been awarded to H. Hart.

Proposals Open.

(NEW YORK CITY).

Dredging.—At piers in North river. Department of Docks, Pier A, North river. December 27.

Repairing Piers and Bulkheads.—Lists of quantities of the engineer's estimates are given in the *City Record*. Department of Docks. December 27.

MISCELLANEOUS.

Pipe, Valves, Etc.—The Secretary of the Water Board, St. Paul, Minn., has been authorized to advertise for proposals for pipe, special castings, valves, valve boxes and stop-cock boxes for next year.

Trestle.—Bridge approach. Mr. Mahoney, Commissmissioner of Public Works, Atlanta, Ga. December 20.

Water Tower.—At Enston Home. Plans at office of Gibbs & Jenkins, 33 Board street, Charleston. A. B. Rose, Chairman, Enston Home, Charleston, S. C. Dec. 20.

Paving.—Specifications at the office of the City Surveyor, Comptroller's Office, New Orleans, La. Dec. 20

City Work.—Pipe sewer, grading and curbing. Separate bids. Street Commissioners Office, Newark, N. J. December 20.

Stone.—2,000 tons. Capt. W. H. Bixby, U. S. Engineer Office, Wilmington, N. C. January 8.

Street Work.—Grading, curbing and paving. City Commissioner's Office, Baltimore, Md. December 21.

Bridge.—Wrought-iron girder bridge. Department of Surveys, City Hall, Philadelphia, Pa. December 21.

Boiler.—For light-house tender "Laurel." Office of the Light-House Board, Treasury Department, Washington, D. C. December 28.

Pipe.—Cast-iron water pipe, from 4-inch to 24-inch. Department of Public Works, Chicago, Ill. December 29.

Dredging.—Nanticoke and St. John's rivers. Wm. F. Smith, U. S. Engineer Office, Wilmington, Del. December 30.

Pipes and Valves.—Sealed proposals will be received by the Water Commissioners, of St. Paul, Minn., until 12 o'clock M., Jan. 7, 1887, for cast-iron pipe and special castings, as follows: 4,300 feet of 4-inch, with the privilege of 3,000 feet additional. 50,000 feet of 6-inch, with the privilege of 20,000 feet additional. 20,000 feet of 12-inch, with the privilege of 5,000 feet additional. 8,900 feet of 16-inch, with the privilege of 1,000 feet additional. 4,900 feet of 20-inch, with the privilege of 2,000 feet additional. 700 feet of 12-inch, extra heavy. Special castings, 50 tons, with the privilege of enough to lay above pipe.

Sealed proposals will be received at the same place and time for furinshing the following water gates in accordance with specifications:

Six (6) 3-inch gates with the privilege of additional. Ten (10) 4-inch gates with the privilege of 5 additional. One hundred and twenty (120) 6-inch gates with the privilege of 50 additional. Twenty-five (25) 12-inch. gates with the privilege of 15 additional. Twelve (12) 16 inch gates with the privilege of 5 additional. Three (3) 20-inch gates with the privilege of 2 additional

Railroads, Bridges and Canals.

The Randolph Bridge across the Missouri.—This bridge crosses the Missouri river five miles east of Kansas City, at the Randolph bluffs; it will bring into the city named the Chicago, Milwaukee & St. Paul R. R. and later the Chicago & Northwestern R. R. The foundations are being built by Wm. Sooy Smith & Son, of New York, with Wm. D. Jenkins as engineer-in-charge and J. E. Willard as superintendent of works. The bridge approach will be 4,500 feet long, 3,000 feet being on wooden trestles and the remaining 1,500 feet on iron trestlework; the bridge proper will be 1,360 feet long in four spans; one 160 feet deck span and three 400 feet through spans. The lower chord will be 80 feet above ordinary stage of water and 50 feet above the high water of 1844. Piers 2, 3 and 4 rest on caissons of wood, 24x60 feet and 24 feet high, sunk by compressed air. At Caisson 4 the rock is 80 feet below the water surface. The caissons are provided with Edison electric lights and telephone communications with the outside. Caissons 2 and 4 are nearly ready to sink and work on Caisson 3 is being rapidly pushed. Pier 1 will rest on a pile foundation. It is expected that the masonry will be completed to the water surface before the February rise in the river, and the piers finished by April 1, and the bridge by August 1. The Keystone Bridge Company, of Pittsburg, Pa., will build the superstructure. The bridge will cost about $1,000 000 in the aggregate, and, if all goes well, be finished in nine months from the first work done.

The Standard Oil Company will erect a new refinery at Franklin, Pa.; $250,000 was voted on December 12 to "commence building." The company owns the natural gas plant at this place.

Canadian Geological Survey.—Parties have returned from the Northwest Territories, after surveying for six months in the region south of the Saskatchewan, between the Rocky Mountain House and Fort Pitt. They discovered soft and anthracite coal in enormous quantities, the former being most plentiful. A section of the country 200 miles in extent is intersected with veins.

The American Exhibition.—A London, Eng., paper says: "Now that it is definitely settled that the Colonial and Indian Exhibit will not re-open next year, attention is being directed to the American Exhibition, to be opened May 2, 1887, at Earl's Court, Kensington. Already a large force of men are at work on the grounds at Earl's Court. The land is now graded, the drain pipes laid, the concrete foundations in place, and the main building is in process of construction. On that portion of the ground set apart for the use of Buffalo Bill's Wild West Exhibit, the arena is laid and ballasted, the camp staked out, and the erection of the grand stand will shortly be commenced.

The Davis Valve.—Messrs. G. M. Davis & Co., 20 South Canal street, Chicago are manufacturing and taking a large number of orders for the "Davis Standard Reducing and Regulating Valve." The object of this valve is the reducing of steam pressure from high to low pressure, and holding same at point required; and is used where water, steam or air need to be controlled automatically, such as steam heating apparatus, dryers, air and water pumps, hydraulic elevators breweries, paper mills, rubber works, etc. They are so constructed as to be easily cleaned, having no rubber packing or springs of any kind to get out of order.

Steel and Iron Works.—The Chicago Steel Co expects to start the new works at Hammond, Ind., on January 1st, when about 100 machines for the manufacture of steel nails will be put in operation. The rolling-mill and Bessemer steel works will also soon be ready for operations.

The Gates Iron Works, 50 South Clinton street, Chicago, are taking a large number of orders, and report business in their line as excellent, with flattering prospects for the new year.

Bridge.—City Engineer S. G. Artingstall, of Chicago, has completed surveys for the erection of a new bridge at Fourteenth street. The bridge will be a single one of iron, with stone pier and abutments.

The Gulf, Houston & Rio Grande Railroad Co. capital stock $1,000,000 has been incorporated in Texas, to extend the Texas Western Railroad from Sealy Westward, by Abraham Cross, John W. Smith, J. L. Mitchell and S. Packard, of Houston and others.

Street Railroad.—About two miles, from the A., T. & S. F. R. R. depot. Proposals must specify the time for franchise to run and rates of fare. R. McCuishon, chairman, Public Grounds and Building Committee, Socorro, N. M. January 17.

Union Pacific R. R.—The income of the Union Pacific R. R. Co. for the nine months ending Sept. 30, as shown in the report presented to Secretary of the Interior Lamar is $19,153,669 expenses and taxes $13,008,427 surplus earnings $6,145,242. This covers 3,531 miles of road.

N. Y., L. E. & W. R. R. Co.—At the annual meeting of the stockholders of the New York, Lake Erie & Western R. R. Co., held in New York on November 30, the annual report which was read showed the gross earnings for the fiscal year ending September 30, to be $22,500,047, operating expenses $6,388,678, net earnings $6,111,409, income from other sources, $646,400, total net earnings, $7,057,868. The old officers were all re-elected.

A Law-suit Turning on a Comma.—John Hill, civil and mechanical engineer, has sued the King Manufacturing Co., Augusta, Ga., for $4,094.60 for work done in connection with the mill. The case turns on the interpretation of the contract, in which the position of a comma takes an important part.

Cable Railroads.—At Pittsburg, Pa., arrangements have been completed for the construction of the Oakland cable line of the Pittsburg, Oakland & East Liberty Passenger R. R.; the cable line will be extended on Wylie and Center avenues.

At Albany, N. Y. a cable road is projected up State street; at present four horses are needed to each car up the whole length of the line. Robert C. Pruyn, President of the National Commercial Bank, Albany, is interested.

Street Railroads.—At New Orleans, La., the franchise for the Canal & Claiborne Street R. R. was recently offered at public auction; the only bid was that of Joseph Hernandez, $25,000. Judge Ogden made an unofficial proposition to give $26,000, it will be considered by the council. Protests were made by the company and G. T. Wharten Collens, the latter claiming that his was the highest bid in September and that the franchise rightly belonged to him.

The North Birmingham Street R. R. Co. has been incorporated at Birmingham, Ala., by John W. Johnston E. M. Tutwiller, and others; capital stock, $100,000.

At Savannah, Ga., a new street railroad will be b ilt; the cars will be built by the Pullman Car Co.

At Richmond, Va., the Richmond Union Passenger R. R. Co. has applied for a charter; dummy engines will be employed until arrangements are perfected for operating by electricity. J. B. Pace, E. D. Christian, and others, are interested.

New Railroads and Extensions.—Chicago, Milwaukee & St. Paul R. R. Engineers are locating the extension from Merrill, Wis., to Rhinelander.—Chicago, Kansas & Nebraska R. R. The line has been completed from St. Joseph west to Horton, Kan., 40 miles; the grading is finished from Horton to Topeka and Hutchinson.—Morris County R. R.—This line from Charlotteburg, N. J., on the N. Y., Susquehanna & Western R. R., to Port Oram, on the Delaware, Lackawanna & Western R. R., 17 miles, is approaching completion. Garret A. Hobart is president and R. T. Low, secretary.—South Atlantic & Ohio R. R. Track-laying has been commenced at Bristol, Tenn., and will be pushed on to Cumberland Gap.—Georgia Midland R. R. Sixty-six miles have been graded and a depot and shops will be erected at once at Columbus, Ga.—St. Louis, Alton, Terre-Haute & Cairo Short Line R. R. It is proposed to extend the line to Paducah, which will make a through line from St. Louis to Paducah.—Columbus, Hope & Greensburg R. R. It is expected that the road will be built from Indianapolis to St. Louis, and that the line from Effingham, Ill., to Switz City, Ind., 98 miles, will be made a part of the system.—New York, Philadelphia & Norfolk R. R. The line is to be extended from Norfolk, Va., to Jacksonville, Fla. H. W. Dunne, superintendent, Cape Charles, Va.—Canadian Pacific R. R. A branch is to be built from Myrtle, Ont., to Coburg.—Fort Worth & Denver R. R. The road will be extended 206 miles to the Canadian river.—Chattanooga & Columbus R. R. Chattanooga, Tenn., has subscribed $100,000, this ensures the building of the line to Rome, Ga.—St. Louis & Chicago R. R. Work is in progress from Litchfield to Springfield, this line is nearly completed and the southern extension from Litchfield, to Mount Olive, Ill., will be finished by January 1.—Atchison, Topeka & Santa Fé R. R. The Rusk Center extension has been completed as far as Nekoma and Alexandria, Kan.; the Indian Territory line is completed from Arkansas City to Willow Springs, I. T.—Kansas, Nebraska & Dakota R. R. The line is completed to Topeka, Kan., which completes the route from Fort Scott.—Chicago & Northwestern R. R. The line is completed from Scribner to Lindsey, Neb., 590.75 miles from Chicago.—New Orleans, Natchez & Fort Scott R. R. The line will probably tap Hot Springs, Ark.; the city has agreed to give a bonus of $50,000 to secure the erection of the shops; the road is a continuation of the Kansas, Nebraska & Dakota R. R.—Gulf, Colorado & Santa Fé R. R. A branch is to be built from Sealy, Tex., westward to Crockett county.—A railroad is projected from Paducah, Ky., to Mount Vernon, Ill., to open up a valuable coal and iron property; representatives of English inventors have been at St. Louis, Mo., recently.—A line is being located from Borotereau, Tex., to the Mexican National R. R. at the Angostura crossing on the Sabinas river; work will be commenced shortly.